Pricing Insurance Risk

Module C: Historical US Property-Casualty Profitability and Volatility

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Stephen J. Mildenhall

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convex risk

independent | informed | imaginative

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C.01. Premium to GDP Ratio, 1923-2021

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Premium to GDP Ratio

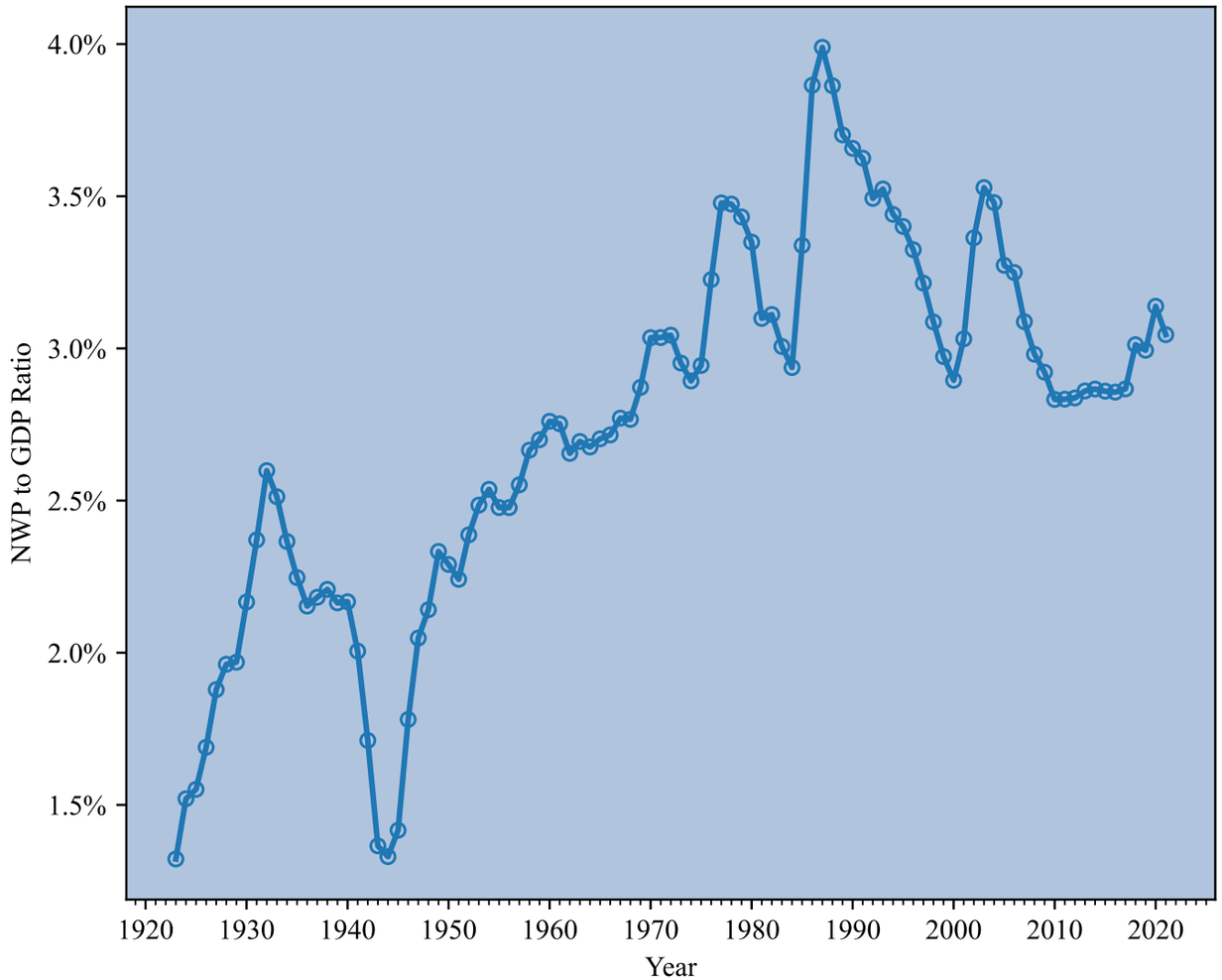

Figure 1: The ratio of US statutory net written premium (NWP) to nominal gross domestic product (GDP) gives a good measure of the insurance market cycle. It measures the penetration of the insurance industry into the economy. GDP and NWP are both are on a nominal basis; inflation cancels in the ratio. COVID-depressed GDP caused the spike in 2020. Source: NAIC US Statutory Compbined P&C Industry premium and GDP from FRED.

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Premium to GDP Ratio: Cyclical Growth Between 1947 and 1997

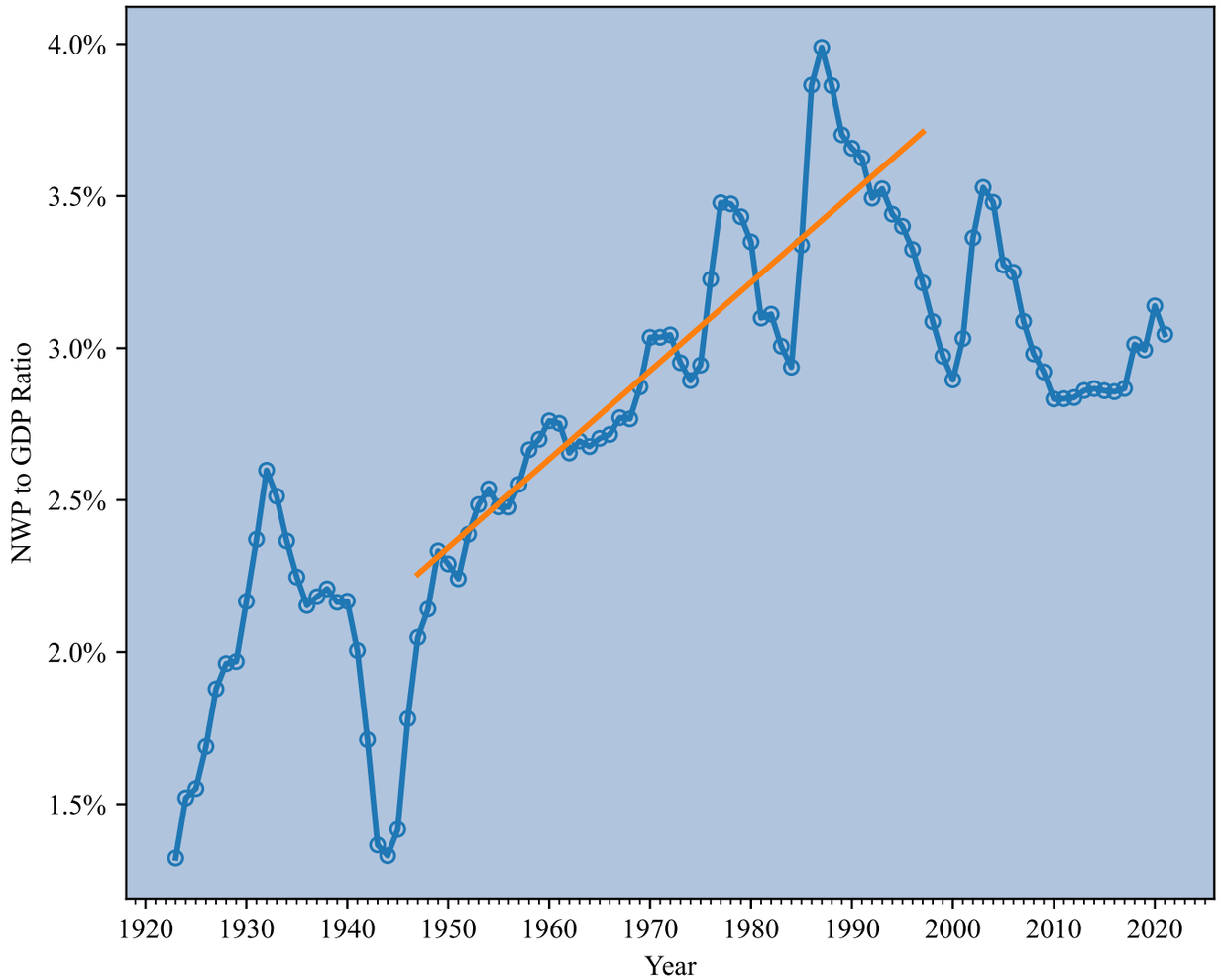

Figure 2: Secular growth from the end of WW2 through 1986 has given way to retrenchment and stabilization. The 1986 watershed saw tax reform, which introduced loss reserve discounting for tax purposes, as well as the claims-made form and absolute pollution exclusion. The period 2008-2017 was unusually stable. It was ended by high catastrophe losses in 2017.

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Misery

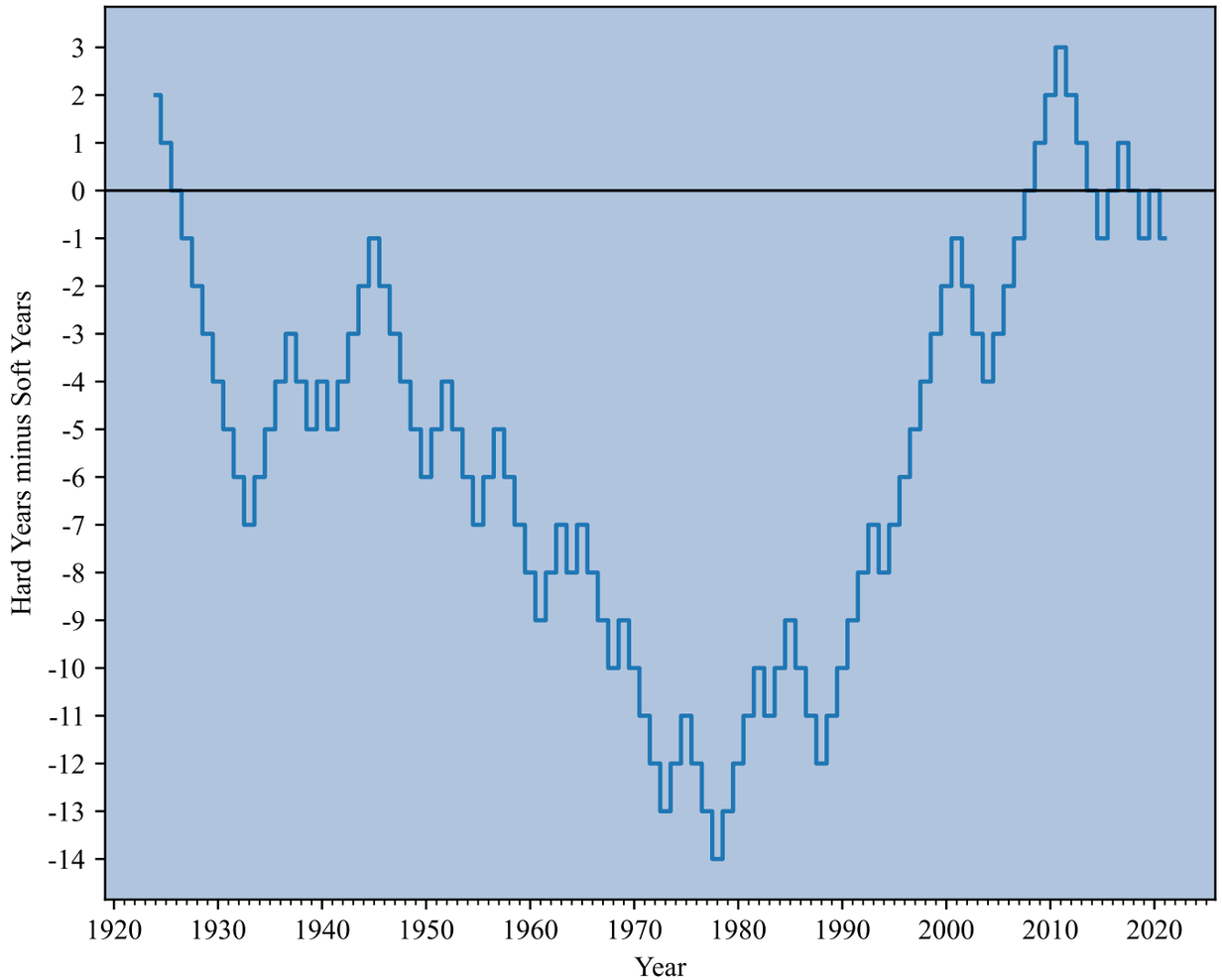

Figure 3: The market spends longer in softening phases than hardening ones. Cumulative net number of increasing or decreasing premium years to 2021.

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Premium to GDP Ratio: 1968 Watershed

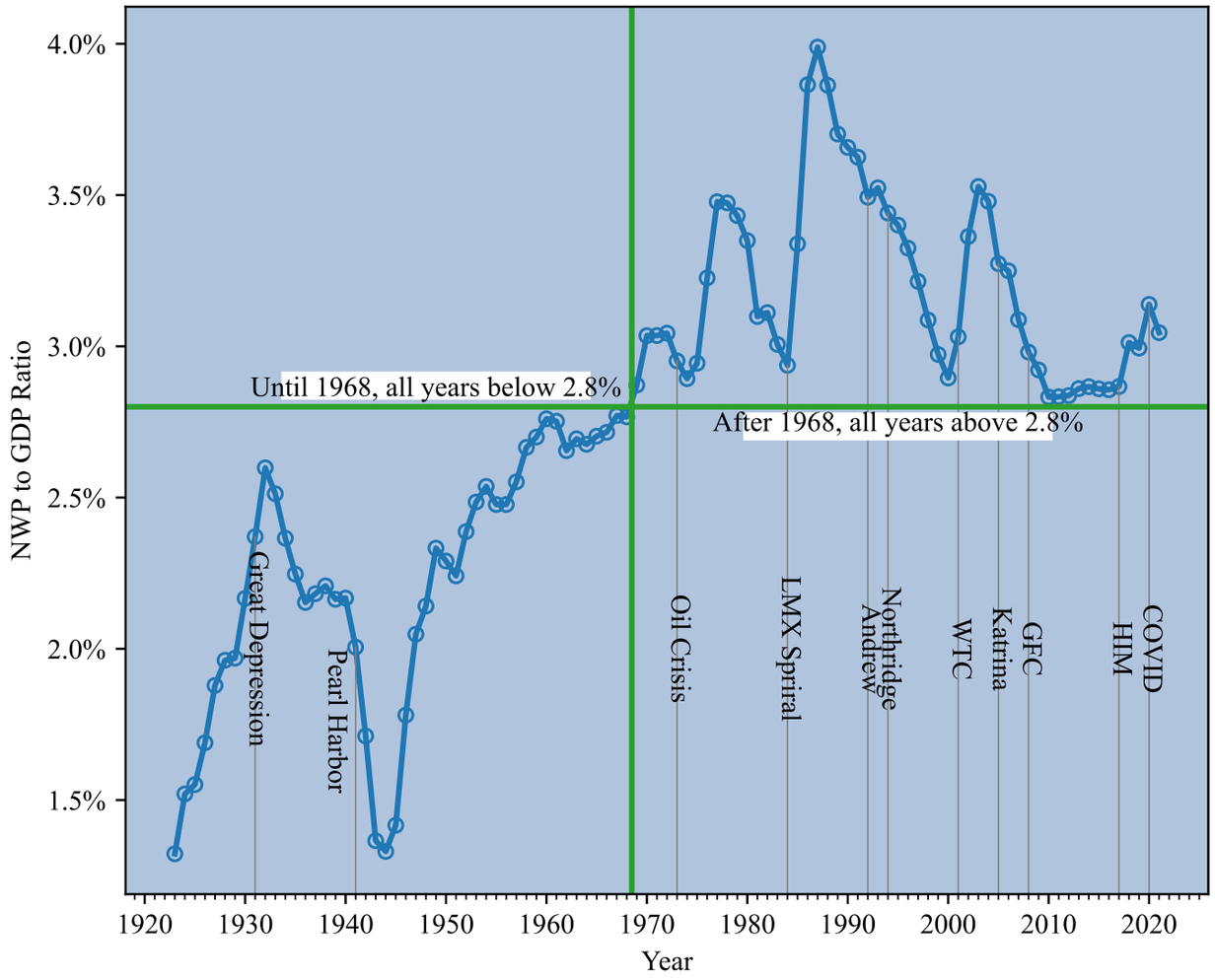

Figure 4: The 2.8 percent level (green lines) separates 1968 and prior from all subsequent years. The ratio was less than 2.8 percent in every year until 1968, while it has been greater than 2.8 percent in every year since. Significant insurance-related events are called out on the x-axis.

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Annual Change in Statutory Surplus, 1932 to 2021

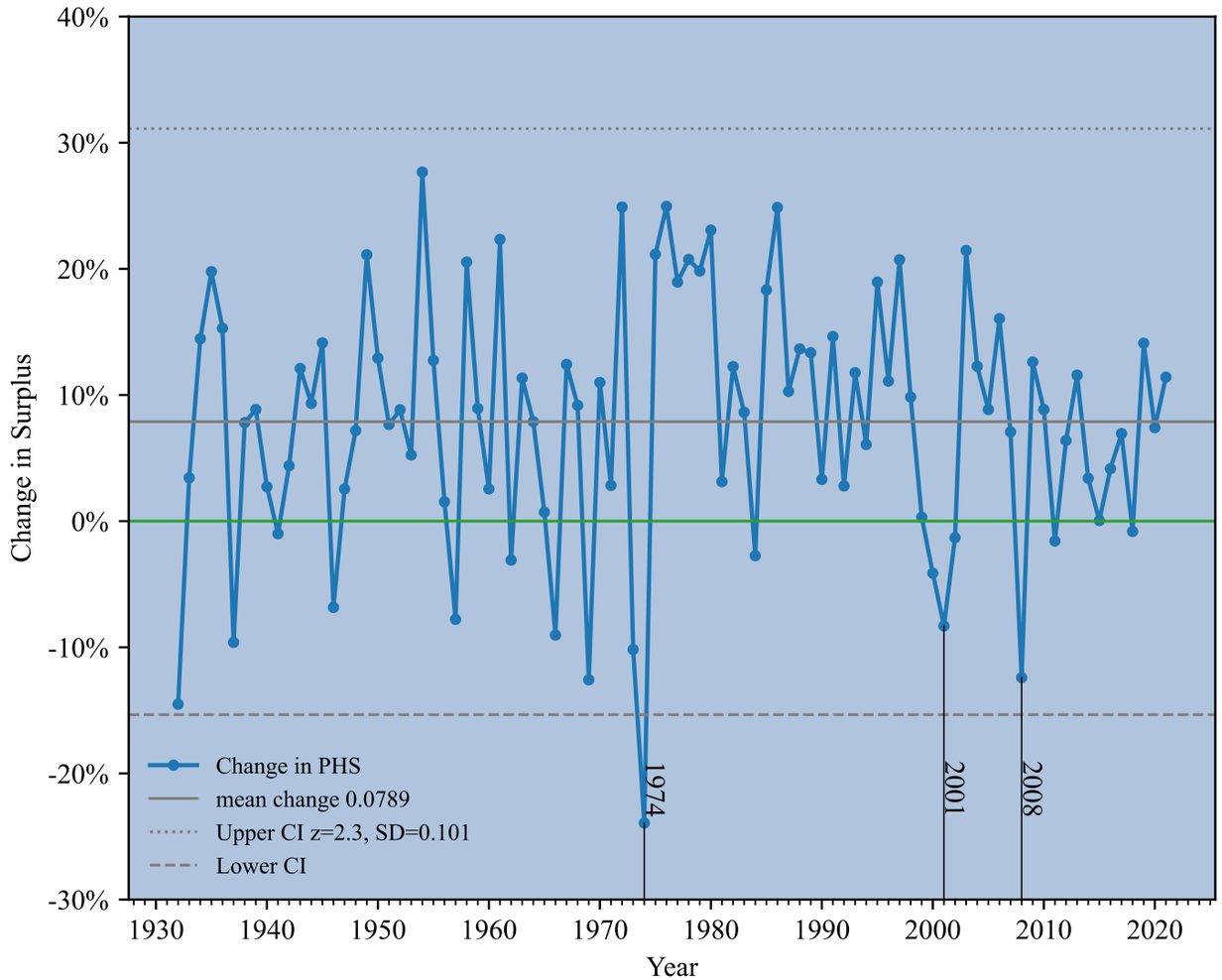

Figure 5: The three most significant post-1968 surplus declines have coincided with significant asset value declines: 1974, 2001 and 2008. 2000-02 is the only consecutive three year decline.

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Annual Change in Statutory Surplus, 1932 to 2021 With 10- And 25-Year Rolling SD

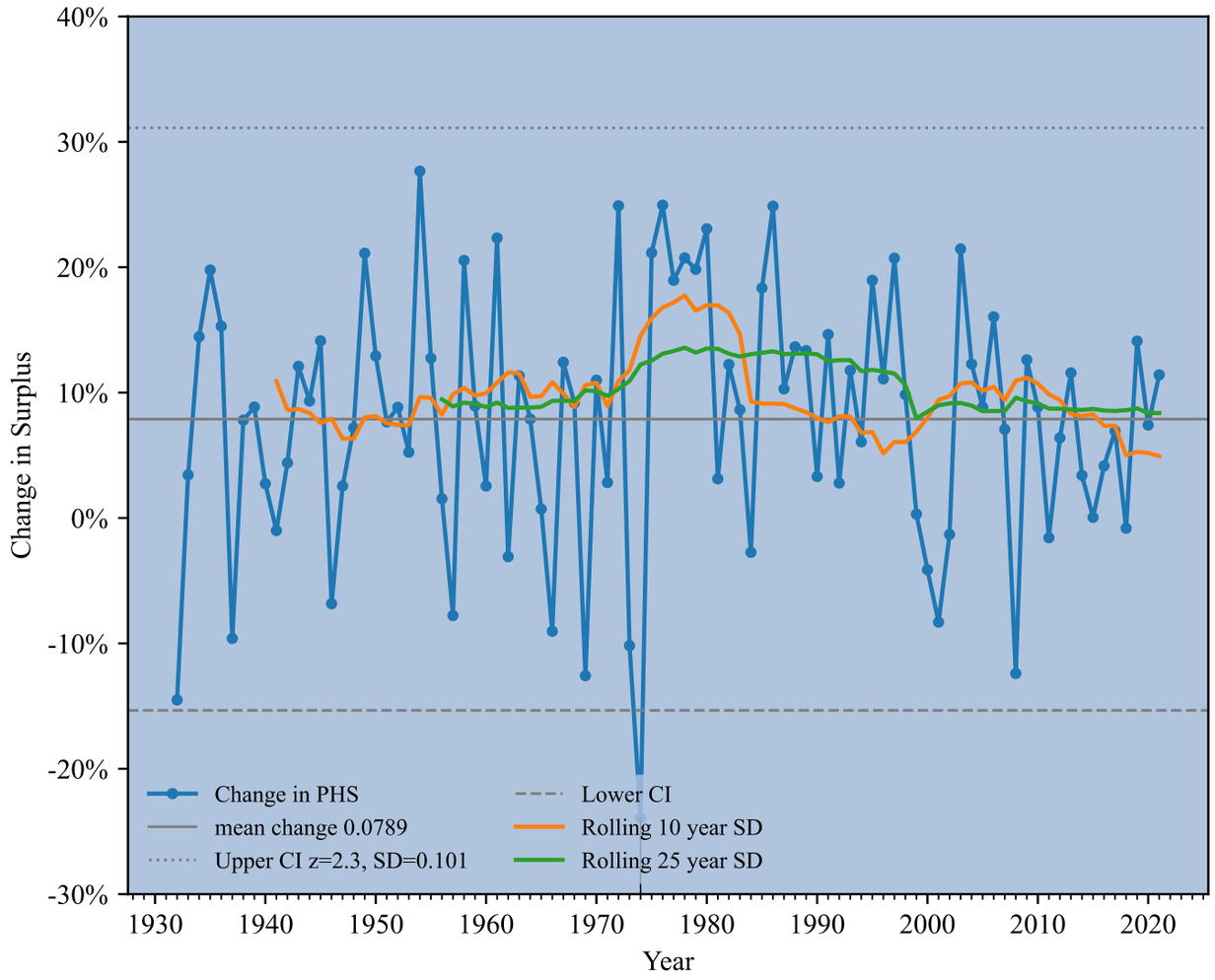

Figure 6: Rolling standard deviation reasonably steady over long-term history, and currently at historically low levels.

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Multi-Year Change in Statutory Surplus, 1932 to 2021

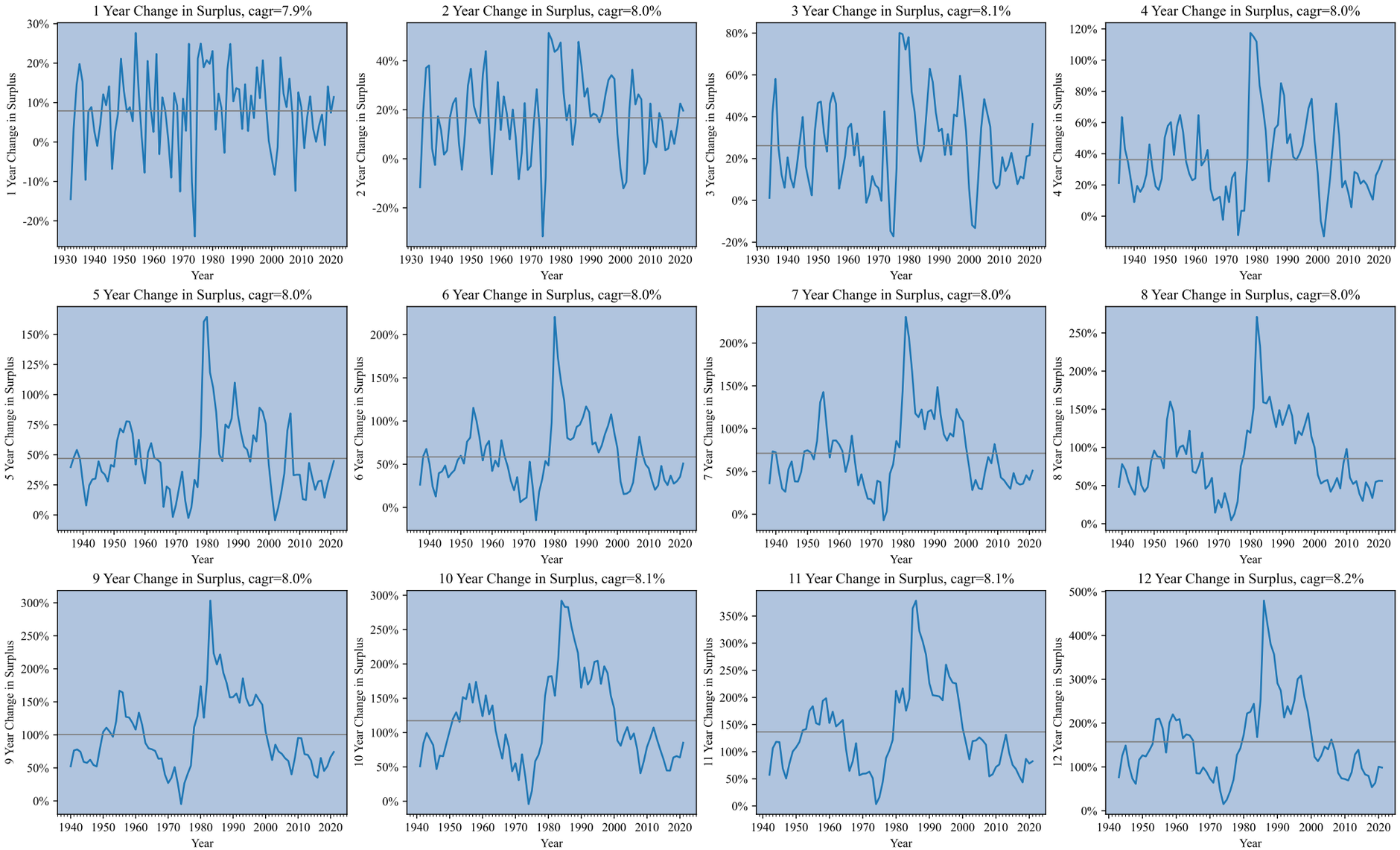

Figure 7: Surplus doubles every nine years, on average. Current period shows historically low long-term growth rates. Not adjusted for inflation.

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Premium to Surplus Ratio, 1932 to 2021

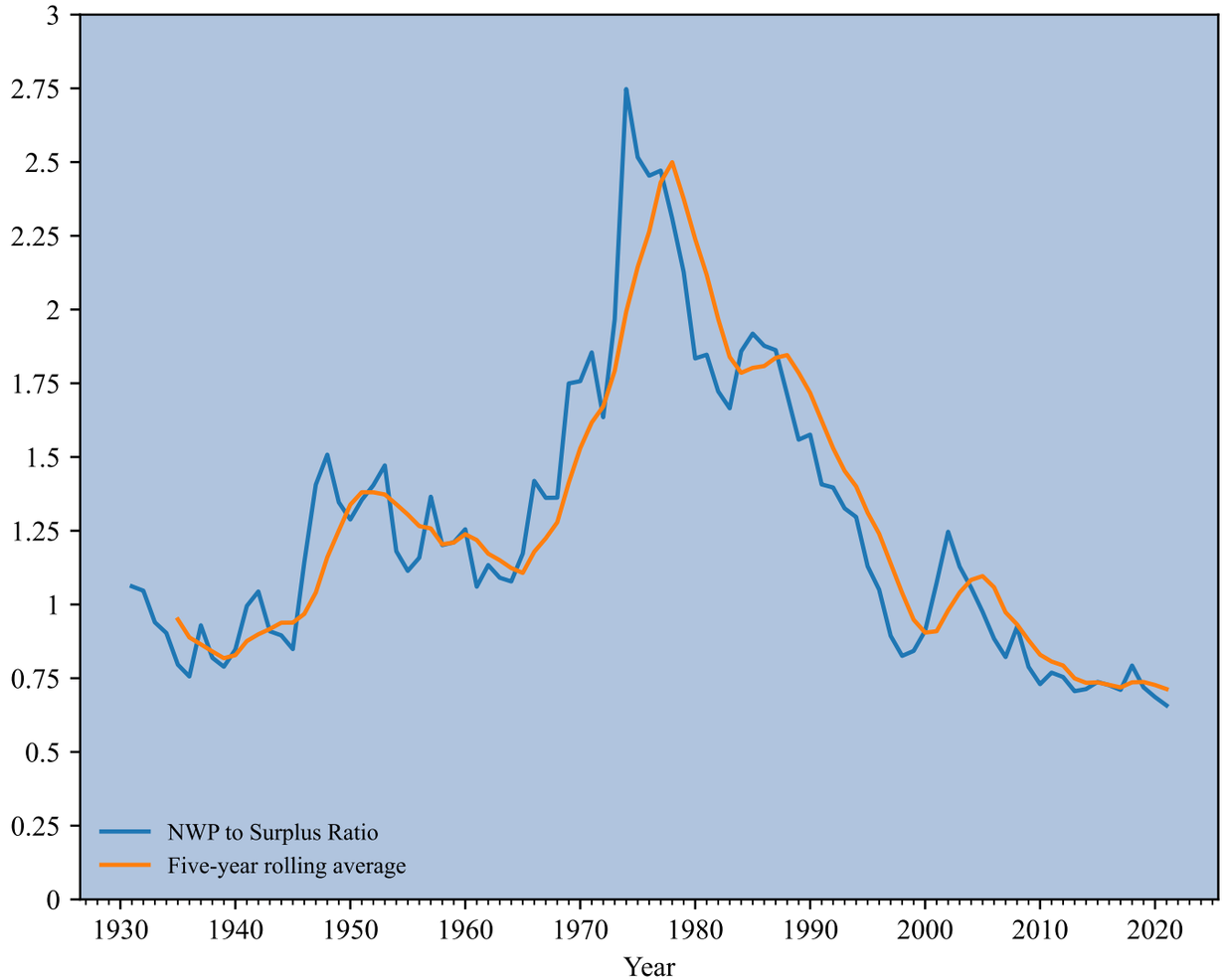

Figure 8: Industry leverage ratios have been decreasing since their mid-1970s high of 2.7 to 1. They have been remarkably stable over the last decade. Current leverage ratios were also seen in the 1930s.

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Premium to GDP vs. Suprlus to GDP

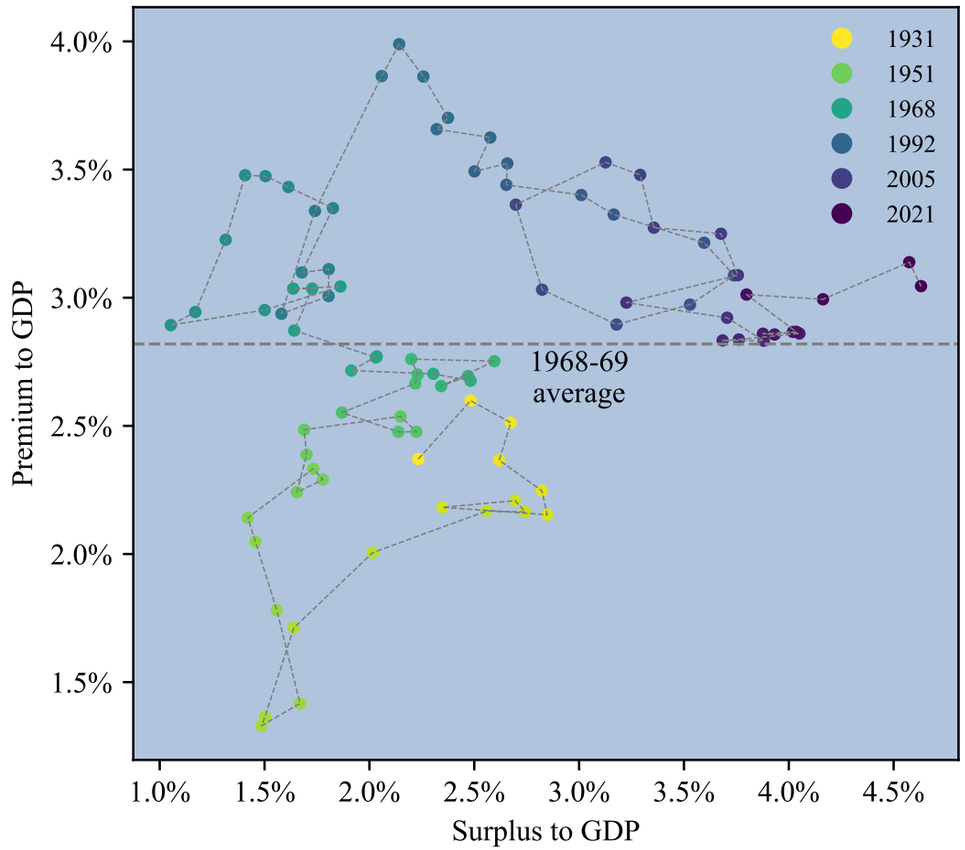

Figure 9: Period since 1968, above the dotted line, has seen much greater swings in surplus to GDP (east west direction) than the earlier period. Current premium penetration is below historical highs but current surplus to GDP ratios are at historic highs. Note relatively high surplus levels in 1930s (yellow): the industry did not return to 1930s levels of relative capitalization until 1995.

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Three Phases of the Market 1931-2021

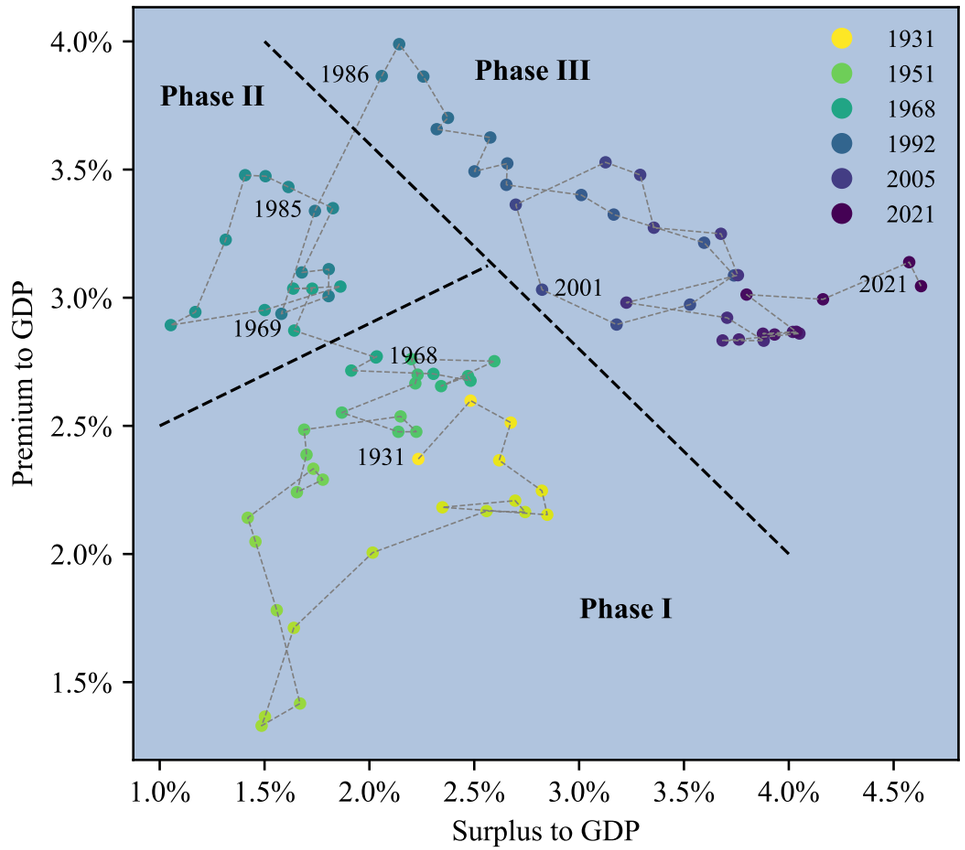

Figure 10: Phase I, 1931-1968: establishment, depression, WW2, and recovery. Phase II, 1969-1985: growth and expansion, industry looking for ways to find coverage. Tax code and high interest rate favorable to casualty business. Phase III, 1986-present: retrenchment and responsibility, secular decline in interest rates and revised tax code emphasize underwriting profits, and growing casualty reserves increase capital intensity. COVID-driven decline in GDP increased surplus to GDP ratio in 2020; strong asset returns lifted surplus further in 2021.

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Market Dynamics Since 1986 Explained by Prior Year Surplus Levels

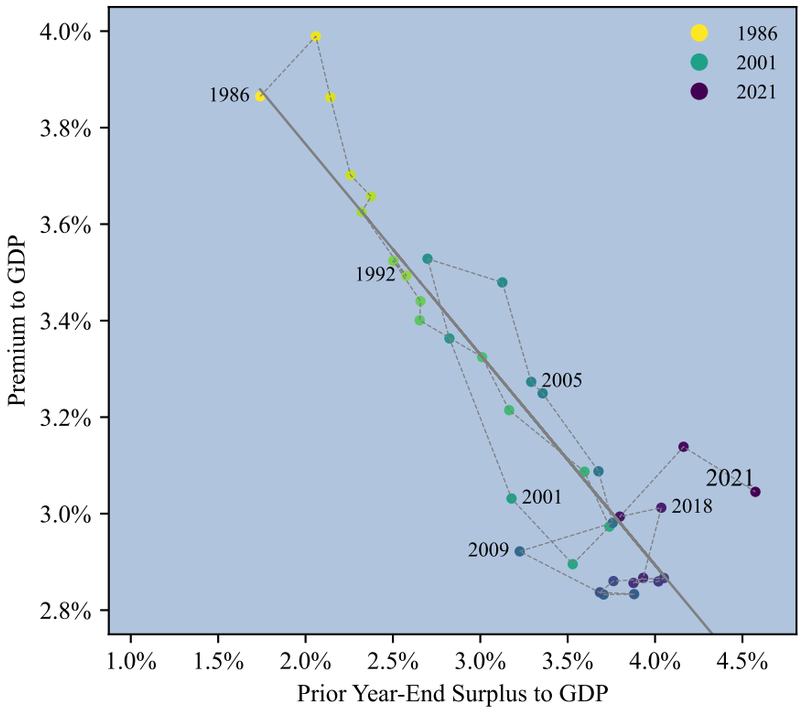

Figure 11: Regression of premium to GDP on prior year surplus to GDP. Anticlockwise cycle between 1994 and 2008!

Results: Ordinary least squares

Model:	OLS	Adj. R-squared:	0.810
Dependent Variable:	PG	AIC:	-364.7639
Date:	2022-07-27 22:18	BIC:	-361.5969
No. Observations:	36	Log-Likelihood:	184.38
Df Model:	1	F-statistic:	149.9
Df Residuals:	34	Prob (F-statistic):	5.17e-14
R-squared:	0.815	Scale:	2.2064e-06

	Coef.	Std.Err.	t	P>|t|	[0.025	0.975]
Intercept	0.0464	0.0012	39.1860	0.0000	0.0440	0.0488
pSG	-0.4362	0.0356	-12.2415	0.0000	-0.5086	-0.3638

Omnibus:	4.207	Durbin-Watson:	0.685
Prob(Omnibus):	0.122	Jarque-Bera (JB):	2.802
Skew:	0.553	Prob(JB):	0.246
Kurtosis:	3.802	Condition No.:	144

- Very strong correlation of premium penetration against prior year-end surplus ratio, regression $R^2 = 0.82$
- Suggests current premium levels will persist while industry capitalization remains strong

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C.02. Surplus to GDP Ratio, 1931-2021

Surplus to GDP Ratio, 1931-2021

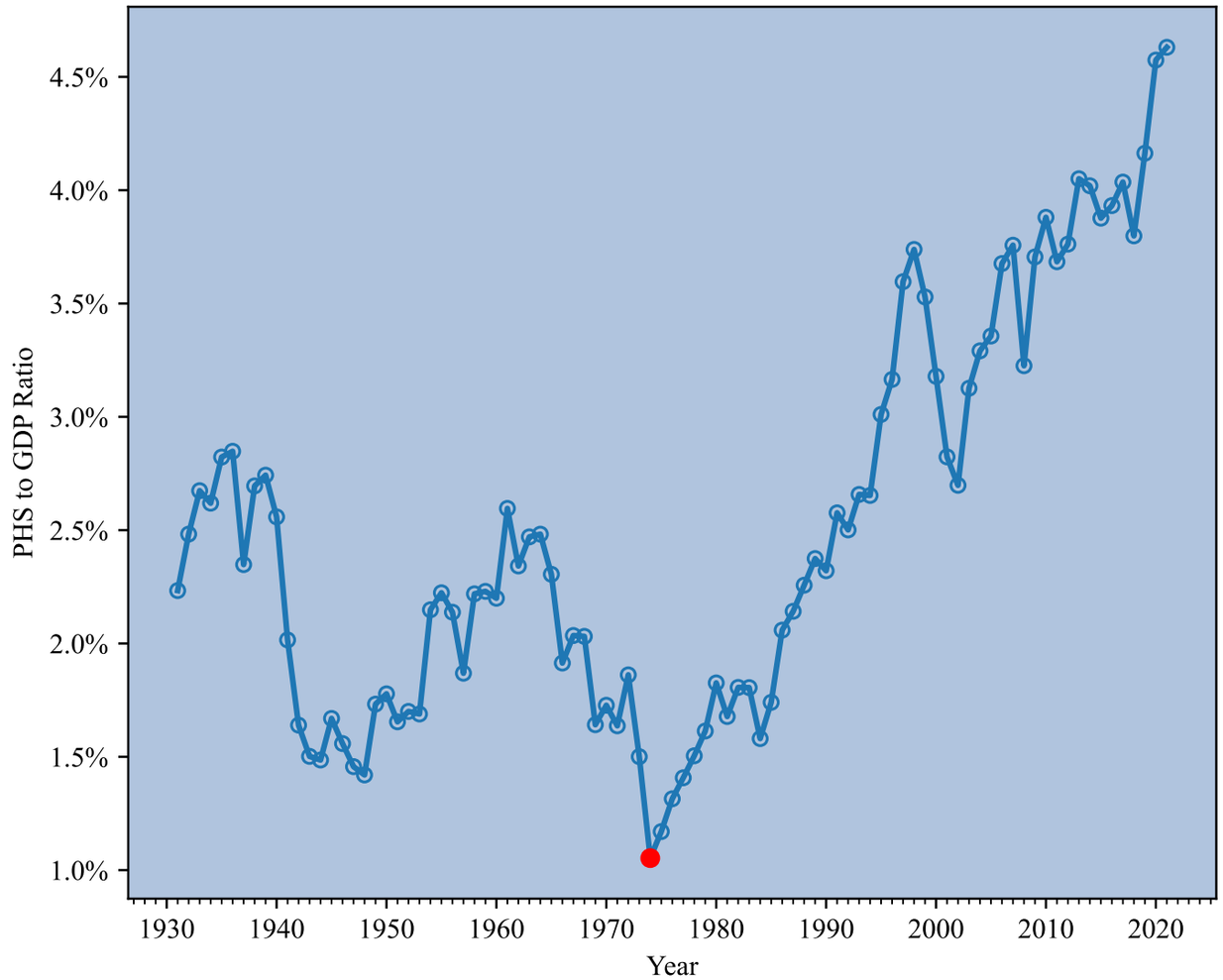

Figure 12: The surplus to GDP ratio shows that relative surplus levels have steadily increased since their recorded low in 1974 of 1.1% (red dot). YE 2021 surplus topped USD 1 trillion for the first time, increasing over 11 percent.

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The Surplus to GDP Ratio Has Increased During the Modern Period, 1968-2020

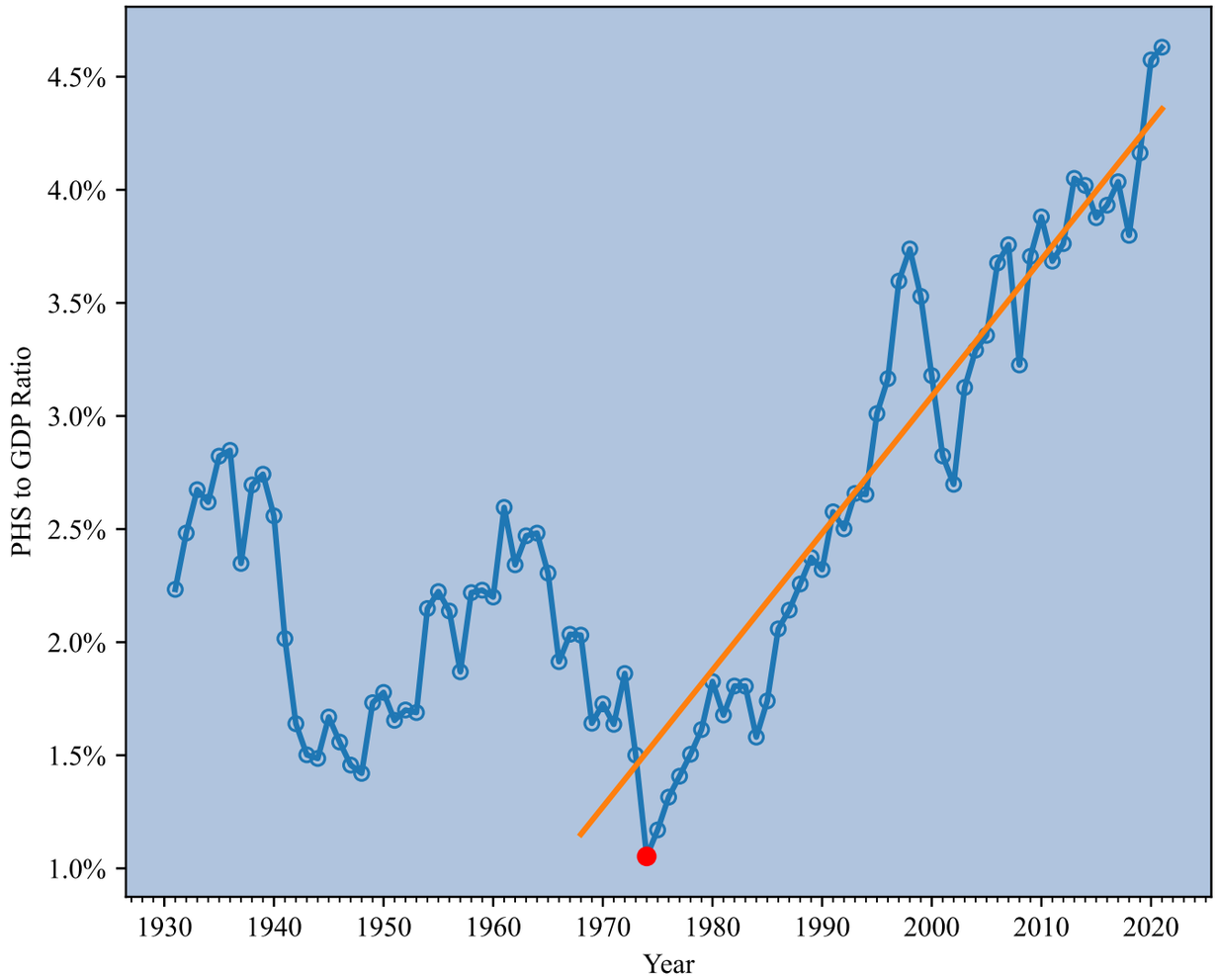

Figure 13: Linear regression has $R^2 = 0.898$, though horrible error auto-correlation until the mid-2000s.

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C.03. Industry Volatility and Profitability Metrics, 1985-2021

Industry Net Volatility and Profitability Metrics, 1985-2021

Table 1: Industry operating and profitability metrics

Quantity	Kind	Full Name	Definition
NEP	USD000	Net earned premium	
NIL	USD000	Net incurred loss	
Exp	USD000	Expenses	All underwriting expenses and other income, excluding LAE
UWGain	USD000	Underwriting gain	
NII	USD000	Net Inv Inc	Net investment income, excluding gain or losses
OP	USD000	UW Operating result	UW Gain plus net inveestment income
GL	USD000	Inv Gain or Loss	Realized and unrealized investment gain, pre-tax 2005-19
NI	USD000	Net income	Statutory net income, page 4
DF	USD000	Dividends and Fin.	Dividends net of capital contributions (generally negative)
PHS	USD000	Polholder Surplus	Policyholder surplus, page 4
NIIR		Net Inv Income Ratio	Net investment income to earned premium
LR, ER	ratio	Loss, Expense Ratio	Loss and expense ratio, to earned premium
CR, OR	ratio	Combined, Operating Ratio	UW Gain, operating result to earned pmreium
NII_PHS	ratio	Net Inc Inc / PHS	NII / PHS
TIG_PHS	ratio	Total Inv Gain / PHS	Total investment income and GL to PHS (tax mis-match)
NI_PHS	ratio	Net Inc / PHS	NI / PHS, quasi-ROE, includes realized gains
OP_PHS	ratio	Op Res / PHS	Operating result to PHS, "operating-ROE"
ROEci	ratio	Comp Inc / PHS	Change in PHS net of dividends and financing / PHS, a comprehensive income ci ROE

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Insurance Volatility and Profitability Metrics Showing Underwriting and Operating

statistic	Net Earned Premium	Net Incurred Loss	Expenses	Undewriting Gain	UW Operating Result	Net Inv Income Ratio	Loss Ratio	Expense Ratio	Combined Ratio	Operating Ratio
min	133.342G	118.572G	39.761G	-50.309G	-11.448G	0.0812	0.652	0.263	0.929	0.8
mean	371.989G	278.213G	105.460G	-8.583G	33.984G	0.122	0.764	0.283	1.05	0.916
max	688.360G	500.088G	193.703G	34.753G	88.101G	0.154	0.889	0.3	1.19	1.04
sd	147.297G	97.827G	42.399G	17.217G	24.091G	0.0222	0.0582	0.00923	0.0587	0.0474
cv	0.396	0.352	0.402	-2.01	0.709	0.182	0.0761	0.0326	0.056	0.0518
growth	-0.0437	-0.0376	-0.0425	-0.946	1.06	0.019	0.00746	0.00186	0.00554	0.00427
r2	0.962	0.951	0.973	0.198	0.514	0.757	0.499	0.0501	0.442	0.125
rse0	29.006G	21.931G	7.018G	15.635G	17.026G	0.0111	0.0418	0.00912	0.0444	0.045
rse	29.452G	22.269G	7.126G	15.875G	17.288G	0.0113	0.0424	0.00926	0.0451	0.0457
slope	0.0359	0.0317	0.0366	-0.0825	0.047	-0.0146	-0.00497	674.224u	-0.00344	-0.00169
year	-26.366T	-17.376T	-7.635T	-1.427T	-3.163T	3.7	8.37	-0.0992	8.27	4.02
ar r2	0.991	0.967	0.994	0.258	0.527	0.854	0.435	0.578	0.432	0.235
ar rse0	13.797G	17.518G	3.256G	15.115G	16.450G	0.00859	0.0419	0.00593	0.0416	0.0393
ar rse	13.797G	17.518G	3.256G	15.115G	16.450G	0.0763	0.163	0.113	0.161	0.178
ar slope	1.03	1.02	1.03	0.504	0.709	0.956	0.618	0.731	0.605	0.447
ar intercept	5.416G	4.208G	1.404G	-3.752G	11.350G	0.00363	0.288	0.0757	0.409	0.504

Table 2: statistics shown for the total US statutory industry. Columns are described on previous slide. Rows are described below. Source: S&P Global Market Intelligence, Statutory Accounts page 4.

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Insurance Volatility and Profitability Metrics: Investments and Returns

statistic	Net Inv Income	Inv Gain or Loss	Net Income	Dividends and Fin.	Polholder Surplus	Net Inc Inc / PHS	Total Inv Gain / PHS	Net Inc / PHS	Op Res / PHS	Comp Inc / PHS	Pre-Tax Income
min	19.508G	-98.513G	-5.786G	-36.665G	75.511G	0.0532	-0.0976	-0.0192	-0.0435	-0.0996	-5.882G
mean	42.567G	30.789G	31.955G	-10.679G	428.483G	0.132	0.119	0.0775	0.0811	0.091	38.797G
max	56.981G	136.021G	70.061G	9.159G	1.051T	0.258	0.205	0.136	0.176	0.246	89.243G
sd	10.366G	54.884G	21.863G	14.946G	260.040G	0.0612	0.0717	0.0351	0.0472	0.0793	25.949G
cv	0.244	1.78	0.684	-1.4	0.607	0.464	0.602	0.453	0.582	0.872	0.669
growth	-0.0264	-0.419	0.143	0.0447	-0.0678	0.0486	0.0362	0.164	1.15	-0.669	-0.0804
r2	0.86	0.276	0.586	0.755	0.952	0.905	0.0279	0.0466	0.00845	0.00329	0.538
rse0	3.938G	48.230G	14.269G	7.503G	57.510G	0.0191	0.073	0.0348	0.0477	0.0804	17.888G
rse	3.999G	50.618G	14.489G	7.618G	58.396G	0.0194	0.0766	0.0353	0.0484	0.0816	18.164G
slope	0.0209	0.185	0.0484	0.112	0.0547	-0.0407	0.0199	-0.00903	-0.00494	0.00475	0.0453
year	-1.736T	-11.464T	-3.065T	2.392T	-46.533T	10.90	-4.66	1.48	0.884	-0.775	-3.483T
ar r2	0.907	768.285u	0.507	0.747	0.984	0.97	0.0359	0.0834	0.158	0.00798	0.47
ar rse0	3.021G	58.337G	15.365G	7.568G	33.276G	0.0102	0.0751	0.0335	0.0399	0.0803	18.798G
ar rse	3.021G	58.337G	15.365G	7.568G	33.276G	0.0387	0.344	0.193	0.181	0.253	18.798G
ar slope	0.904	0.0317	0.713	0.859	1.06	0.946	-0.194	0.281	0.357	0.0891	0.679
ar intercept	5.062G	31.395G	10.616G	-2.384G	4.198G	0.0016	0.14	0.0571	0.0553	0.0809	14.148G

Table 3: Statistics shown for the total US statutory industry. Columns are described on above. Rows are described below. Source: S&P Global Market Intelligence, Statutory Accounts page 4.

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Insurance Volatility and Profitability Metrics

Gloss for rows

- `growth` is the average anuual growth rate
- `r2`, `rse0`, `slope`, `year` are the R^2, residual square error, slope and intercept for a regression of each variable against time (year)
- `rse` equals `rse0` plus the standard error of the slope parameter, giving a better indication of uncertainty
- `ar_r2`, `ar_rse0`, `ar_rse`, `ar_slope`, `ar_intercept` are the same statistics for an AR(1) autoregressive model

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Time Series of Volatility and Profitability Metrics

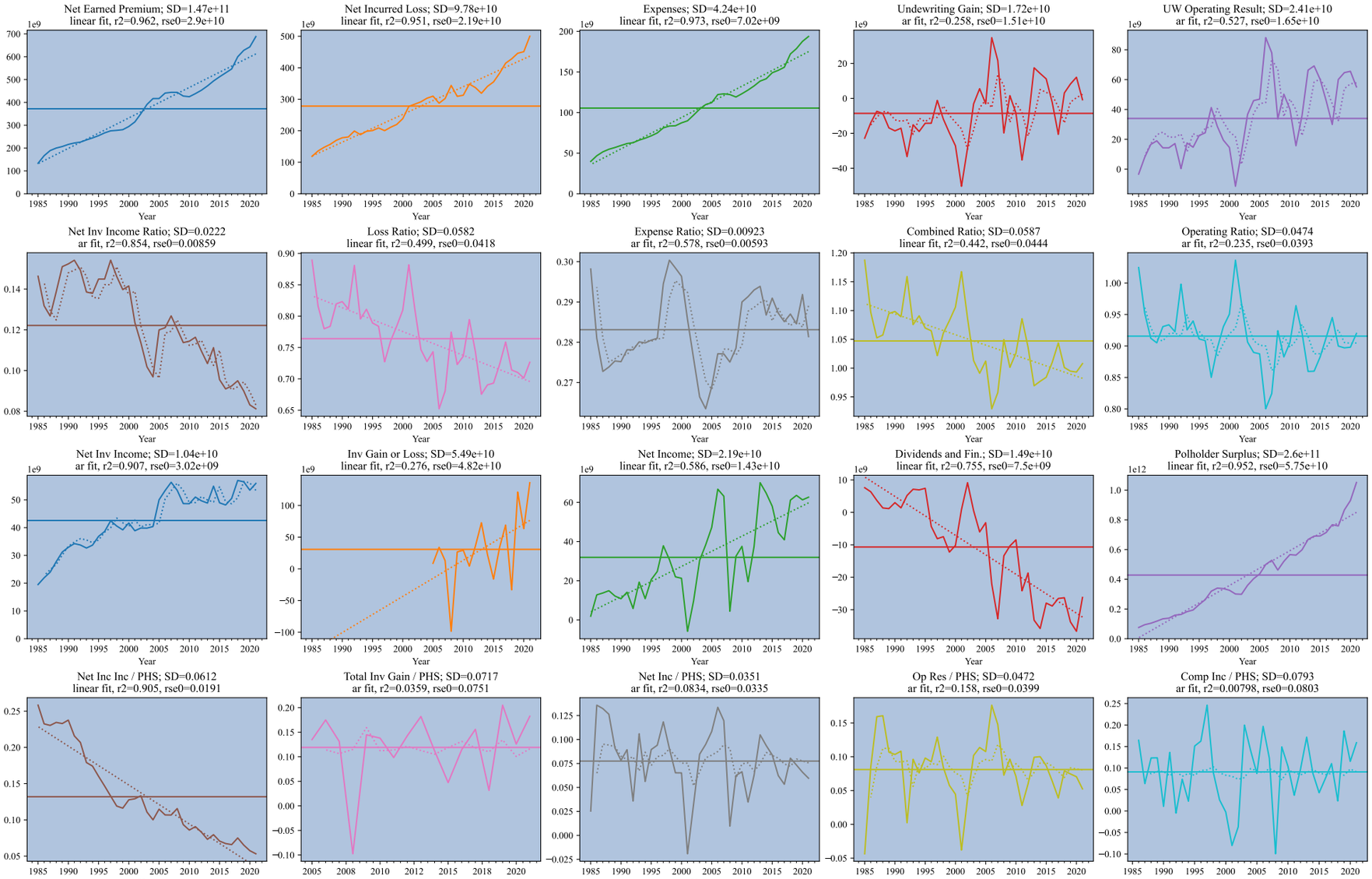

Figure 14: Time series of the variables from the previous table. Declining investment income and increasing volatility of gains and loss are particularly evident. See gloss on next slide.

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Time Series of Volatility and Profitability Metrics

Title decoder: `Net Earned Premium; SD=1.47e+11 linear fit, r2=0.962, rse0=2.9e+10`

- `CR` is the variable name, e.g., combined ratio
- `SD` standard deviation
- If the variable appears to have a `linear` trend show the R^2 and residual standard error of a regression against time
- If it appears autoregressive `ar` show statistics for a fit against the lagged variable
- Linear trend is selected if the linear model R^2 is > 0.9 or is greater than the `ar` model R^2

Line legend

- Solid line is the statistic
- Horizontal line is its mean value
- Dotted line is the `linear` (straight) or `ar` fit (not straight, and appears lagging)

Interpretation

- `rse` significantly less than `SD` suggests potentially explainable variation
- Expenses (`Exp`) and surplus (`PHS`) have a much lower uncertainty than their `SD` suggests because they have a clear trend
- Almost all the variability in `UWGain` is unexpected
- `CR` may have a slightly predictable component—corresponding to the autoregressive underwriting cycle

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C.04. Direct and Net Volatility and Profitability by Major Line, 1992-2021

Direct and Net Calendar Year Loss Ratio Average, Standard Deviation, Coefficient of Variation, Skewness, and Kurtosis by Major Line

	Direct					Net					Diff				
Line	**Average**	**SD**	**CV**	**Skew**	**Kurt**	**Average**	**SD**	**CV**	**Skew**	**Kurt**	**Average**	**SD**	**CV**	**Skew**	**Kurt**
Personal Auto	0.769	0.040	0.052	-0.449	1.02	0.766	0.039	0.051	-0.471	0.79	0.003	0.001	0.001	0.022	0.229
total	0.752	0.064	0.086	0.521	0.592	0.752	0.056	0.074	0.574	0.26	-0.000	0.008	0.011	-0.054	0.332
Other Comm	0.648	0.072	0.111	0.684	1.25	0.65	0.053	0.081	0.839	0.578	-0.002	0.019	0.030	-0.155	0.677
Comm Auto	0.752	0.079	0.106	-0.016	-0.866	0.749	0.072	0.096	-0.012	-0.937	0.002	0.008	0.010	-0.004	0.072
Inland Marine	0.55	0.081	0.146	0.69	-0.038	0.568	0.059	0.103	0.033	-1.152	-0.017	0.022	0.043	0.657	1.11
CMP	0.717	0.107	0.149	0.414	0.163	0.717	0.087	0.121	0.18	-0.791	-0.000	0.020	0.028	0.234	0.954
Workers Comp	0.767	0.108	0.141	0.064	-0.594	0.762	0.103	0.135	-0.081	-0.701	0.005	0.006	0.007	0.145	0.107
Homeowners	0.763	0.161	0.21	1.68	4.56	0.765	0.128	0.168	1.69	5.5	-0.002	0.032	0.043	-0.011	-0.941
Liability	0.853	0.159	0.186	0.758	-0.420	0.83	0.157	0.189	0.824	-0.495	0.024	0.002	-0.003	-0.066	0.075
Med Mal	0.837	0.211	0.252	0.754	-0.157	0.834	0.197	0.236	0.844	0.159	0.003	0.014	0.016	-0.089	-0.316
Comm Property	0.692	0.309	0.446	1.58	2.18	0.677	0.185	0.273	1.61	4.4	0.015	0.124	0.173	-0.034	-2.227
Reinsurance	nan	nan	nan	nan	nan	0.813	0.312	0.384	2.23	7.95	nan	nan	nan	nan	nan
Fin Guaranty	0.61	0.706	1.16	2.32	5.63	0.606	0.627	1.04	2.05	4.13	0.004	0.079	0.121	0.269	1.5

Table 4: The average, standard deviation, coefficient of variation, skewness and kurtosis of direct and net loss ratio, by major line. Sorted by Net CV. Exact grouping of statutory lines shown on next slide. Source: Industry Combined Direct Statutory IEE, 1996-2021.

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Direct and Net Calendar Year Combined Ratio Average, Standard Deviation, and Coefficient of Variation by Major Line

	Direct			Net			Diff		
Line	Average	SD	CV	Average	SD	CV	Average	SD	CV
Personal Auto	1.01	0.043	0.043	1.01	0.039	0.038	0.002	0.005	0.004
Other Comm	0.935	0.073	0.078	0.972	0.047	0.048	-0.036	0.026	0.030
total	1.02	0.067	0.065	1.04	0.056	0.054	-0.013	0.011	0.011
Comm Auto	1.04	0.083	0.079	1.05	0.076	0.072	-0.007	0.007	0.007
CMP	1.05	0.112	0.107	1.08	0.093	0.086	-0.027	0.019	0.021
Inland Marine	0.854	0.091	0.106	0.917	0.080	0.087	-0.064	0.011	0.019
Workers Comp	1.05	0.115	0.11	1.05	0.102	0.098	-0.003	0.013	0.012
Homeowners	1.06	0.164	0.156	1.07	0.133	0.124	-0.015	0.031	0.032
Liability	1.14	0.162	0.143	1.14	0.155	0.137	-0.000	0.007	0.006
Med Mal	1.11	0.35	0.316	1.07	0.186	0.174	0.036	0.164	0.142
Comm Property	0.986	0.315	0.319	1.02	0.201	0.198	-0.030	0.114	0.121
Reinsurance	nan	nan	nan	1.16	0.365	0.316	nan	nan	nan
Fin Guaranty	0.806	0.876	1.09	0.909	0.596	0.655	-0.103	0.28	0.432

Table 5: The average, standard deviation, and coefficient of variation of direct combined ratio, by major line. For most lines combined ratio SD is higher than loss SD, indicating pro-cyclical expenses. LAE included with loss. Sorted by Net CV. Direct minus net equals assumed minus ceded, and so does only proxies ceded. Broadly, expect net CR to be greater than direct, reflecting the cost of reinsurance, and SD to be lower, reflecting its volatility reduction. This is true for all lines execpt Personal Auto. Personal Auto cessions tend to involve high loss ratio business ceded to residual market pools. Exact grouping of statutory lines shown on next slide. Source: Industry Combined Direct Statutory IEE, 1996-2017.

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Direct and Net Average Loss Ratio and Combined Ratio by Line

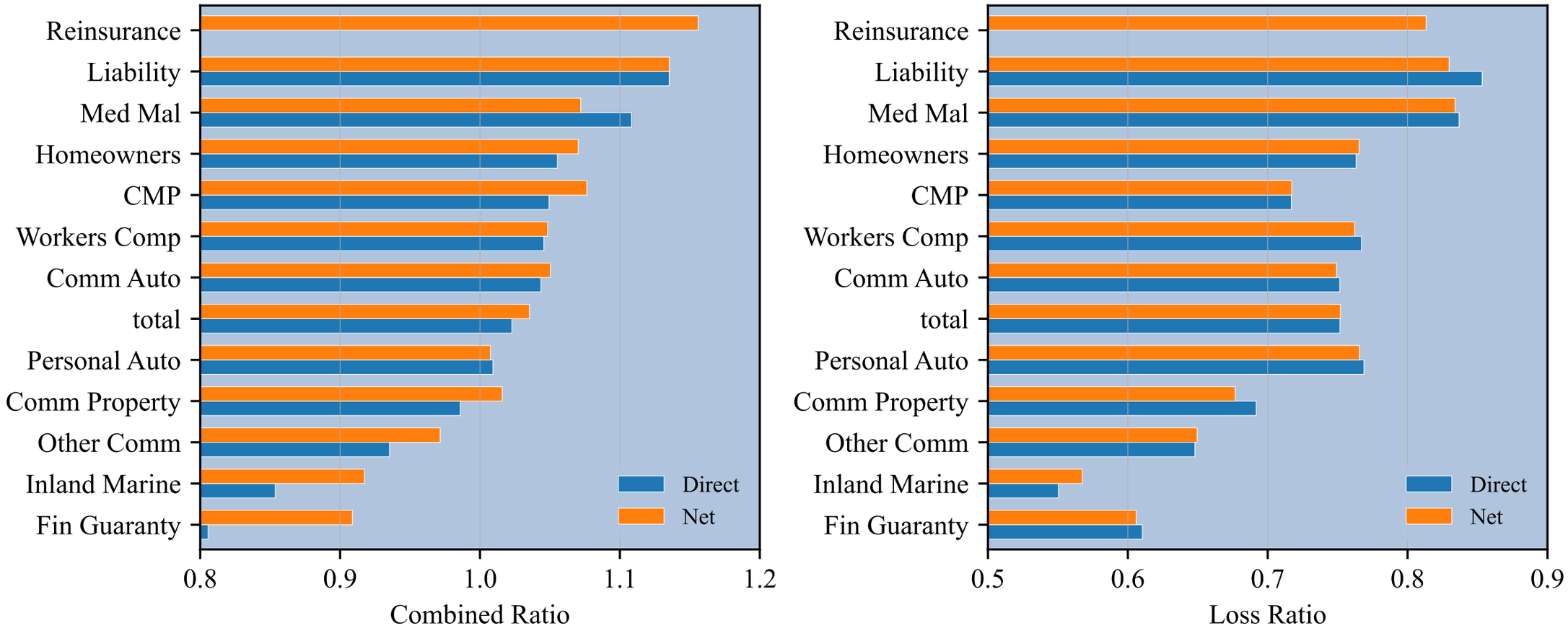

Figure 15: Lines sorted by descending net combined ratio.

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Direct and Net Average Combined Ratio vs. Standard Deviation Combined Ratio

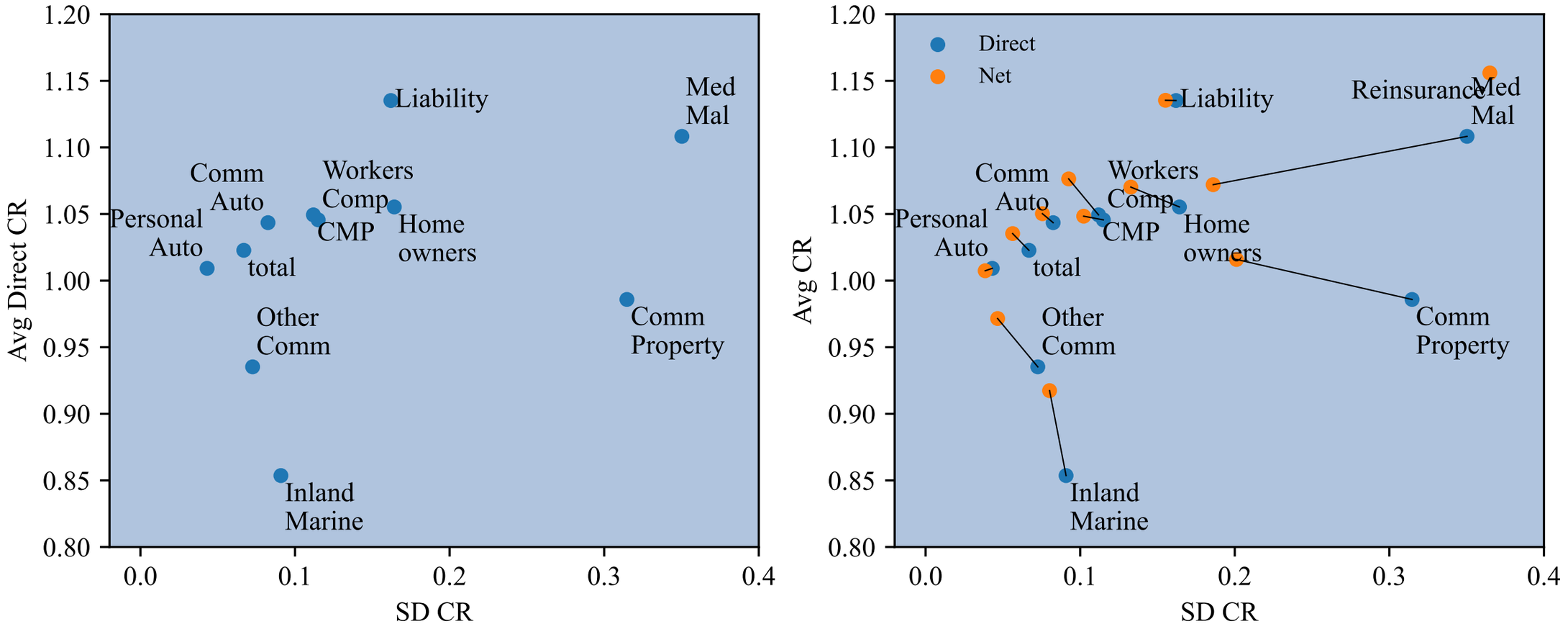

Figure 16: Left: direct, right: direct and net, with joining line. Expect imppact of reinsurance to be in the northwest direction: lower standard deviation but higher combined ratio. This is the case for most lines. Risk benefit most evident for commercial property.

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Mapping Statutory Lines to Major Lines

US Statutory lines grouped as follows

- CMP
  - Commercial Multiple Peril (Liability Portion), Commercial Multiple Peril (Non-Liability Portion)
- Comm Auto
  - Commercial Auto Liability, Commercial Auto Physical Damage
- Comm Property
  - Allied Lines, Earthquake, Fire, Glass
- Fin Guaranty
  - Financial Guaranty, Mortgage Guaranty
- Homeowners
  - Farmowners Multiple Peril, Federal Flood, Homeowners Multiple Peril
- Inland Marine
  - Inland Marine
- Liability
  - Other Liability, Other Liability - Claims-Made, Other Liability - Occurrence, Products Liability
- Med Mal
  - Medical Professional Liability
- Other Comm
  - Aggregate Write-Ins For Other Lines Of Business, Aircraft (All Perils), Boiler And Machinery, Burglary And Theft, Credit, Credit A & H, Fidelity, Group A&H, International, Multiple Peril Crop, Ocean Marine, Other A&H, Private Crop, Surety, Warranty
- Personal Auto
  - Private Passenger Auto Liability, Private Passenger Auto Physical Damage
- Reinsurance
  - Reinsurance-Nonproportional Assumed
- Workers Comp
  - Excess Workers' Compensation, Workers' Compensation
- total
  - Totals (Lines 1 Through 34)

- Federal Flood included with Homeowners
- Liability computed as total minus all other lines owing to Occurrence vs. Claims Made coding change in original data source
- Earthquake with Comm Property: Northridge was a personal lines event but the CEA greatly reduced personal lines quake premium

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Loss Ratio Correlation by Major Line

name	CMP	Comm Auto	Comm Property	Fin Guaranty	Home-owners	Inland Marine	Liability	Med Mal	Other Comm	Personal Auto	Workers Comp	total
CMP	1	0.539	0.731	-0.213	0.754	0.667	0.578	0.649	0.528	0.313	0.396	0.893
Comm Auto	0.539	1	0.306	-0.474	0.021	0.213	0.281	0.544	0.384	0.599	0.076	0.405
Comm Property	0.731	0.306	1	-0.195	0.634	0.74	0.345	0.346	0.347	0.225	0.114	0.709
Fin Guaranty	-0.213	-0.474	-0.195	1	0.016	-0.078	-0.340	-0.528	-0.194	-0.079	0.154	-0.045
Homeowners	0.754	0.021	0.634	0.016	1	0.639	0.379	0.306	0.273	0.070	0.298	0.766
Inland Marine	0.667	0.213	0.74	-0.078	0.639	1	0.238	0.283	0.468	0.050	0.213	0.633
Liability	0.578	0.281	0.345	-0.340	0.379	0.238	1	0.803	0.545	0.239	0.508	0.704
Med Mal	0.649	0.544	0.346	-0.528	0.306	0.283	0.803	1	0.656	0.277	0.502	0.661
Other Comm	0.528	0.384	0.347	-0.194	0.273	0.468	0.545	0.656	1	0.211	0.528	0.599
Personal Auto	0.313	0.599	0.225	-0.079	0.070	0.050	0.239	0.277	0.211	1	0.389	0.481
Workers Comp	0.396	0.076	0.114	0.154	0.298	0.213	0.508	0.502	0.528	0.389	1	0.611
total	0.893	0.405	0.709	-0.045	0.766	0.633	0.704	0.661	0.599	0.481	0.611	1

Table 6: Pearson correlation coefficient between direct loss ratios by major line.

name	CMP	Comm Auto	Comm Property	Fin Guaranty	Home-owners	Inland Marine	Liability	Med Mal	Other Comm	Personal Auto	Reinsur-ance	Workers Comp	total
CMP	1	0.538	0.637	-0.145	0.793	0.76	0.611	0.559	0.597	0.384	0.353	0.329	0.85
Comm Auto	0.538	1	0.318	-0.471	0.133	0.286	0.118	0.441	0.308	0.637	-0.020	-0.115	0.36
Comm Property	0.637	0.318	1	-0.093	0.521	0.553	0.437	0.195	0.269	0.249	0.488	-0.020	0.586
Fin Guaranty	-0.145	-0.471	-0.093	1	0.188	0.248	-0.275	-0.530	-0.297	-0.178	-0.190	0.266	0.036
Homeowners	0.793	0.133	0.521	0.188	1	0.673	0.57	0.332	0.39	0.278	0.383	0.462	0.854
Inland Marine	0.76	0.286	0.553	0.248	0.673	1	0.365	0.201	0.363	0.15	0.365	0.343	0.666
Liability	0.611	0.118	0.437	-0.275	0.57	0.365	1	0.646	0.724	0.248	0.674	0.385	0.752
Med Mal	0.559	0.441	0.195	-0.530	0.332	0.201	0.646	1	0.881	0.337	0.39	0.396	0.597
Other Comm	0.597	0.308	0.269	-0.297	0.39	0.363	0.724	0.881	1	0.323	0.444	0.547	0.693
Personal Auto	0.384	0.637	0.249	-0.178	0.278	0.15	0.248	0.337	0.323	1	-0.063	0.275	0.573
Reinsurance	0.353	-0.020	0.488	-0.190	0.383	0.365	0.674	0.39	0.444	-0.063	1	0.188	0.464
Workers Comp	0.329	-0.115	-0.020	0.266	0.462	0.343	0.385	0.396	0.547	0.275	0.188	1	0.593
total	0.85	0.36	0.586	0.036	0.854	0.666	0.752	0.597	0.693	0.573	0.464	0.593	1

Table 7: Pearson correlation coefficient between net loss ratios by major line.

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Loss Ratio, Premium Change, and Loss Change Correlation

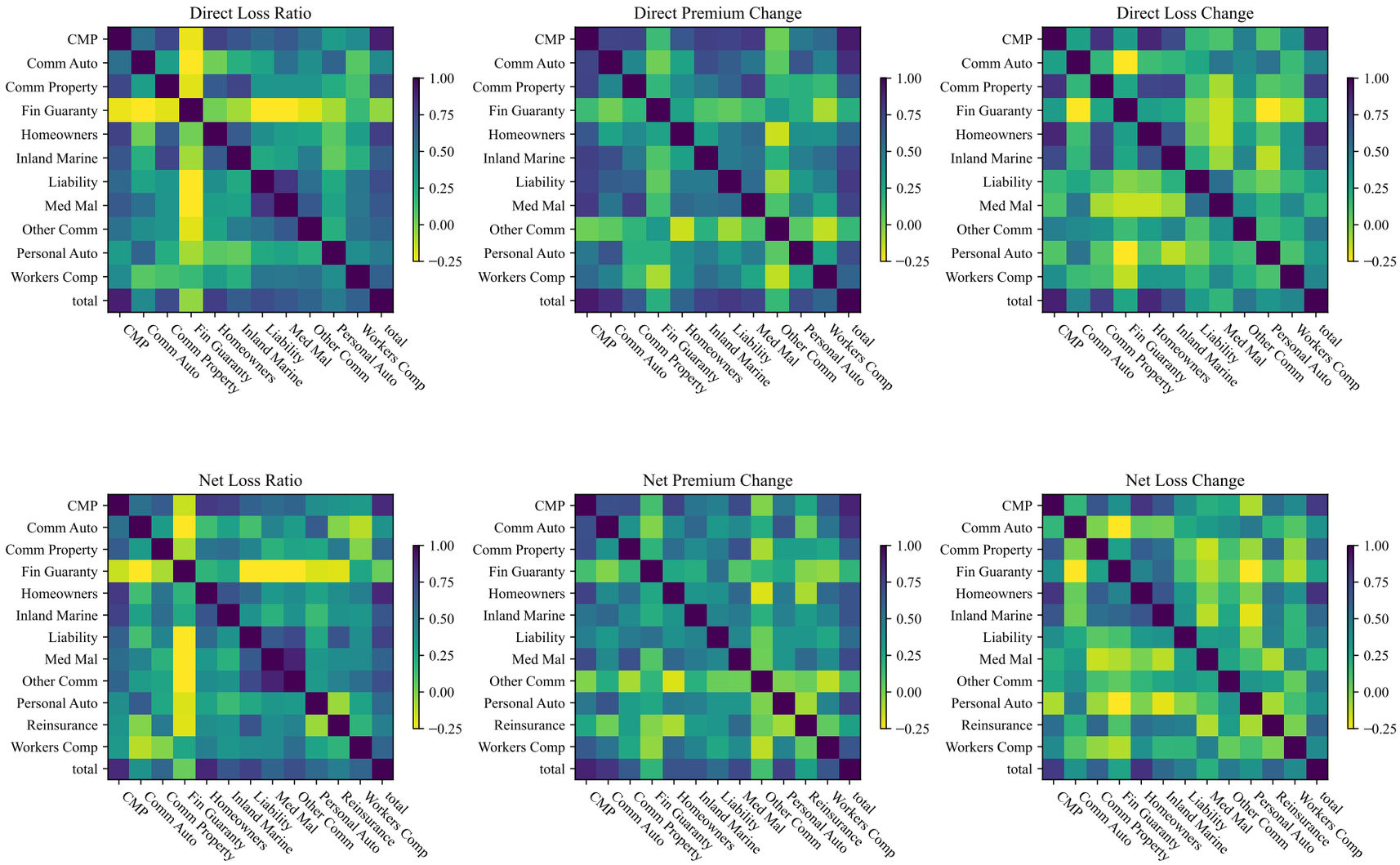

Figure 17: Premium and loss change is year over year change in total losses. It is another measure of the degree to which the cycle for a line is correlated with the overall market. Numerical values given below. Direct and net views.

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Correlation Between Annual Change in Losses, by Major Line

name	CMP	Comm Auto	Comm Property	Fin Guaranty	Home-owners	Inland Marine	Liability	Med Mal	Other Comm	Personal Auto	Workers Comp	total
CMP	1	0.292	0.815	0.308	0.866	0.713	0.164	0.102	0.46	0.089	0.379	0.892
Comm Auto	0.292	1	0.171	-0.270	0.138	0.171	0.253	0.51	0.402	0.522	0.148	0.423
Comm Property	0.815	0.171	1	0.265	0.732	0.745	0.135	-0.087	0.357	0.078	0.117	0.769
Fin Guaranty	0.308	-0.270	0.265	1	0.303	0.264	-0.018	-0.145	0.143	-0.342	-0.131	0.264
Homeowners	0.866	0.138	0.732	0.303	1	0.678	0.022	-0.146	0.304	0.083	0.332	0.858
Inland Marine	0.713	0.171	0.745	0.264	0.678	1	0.203	-0.064	0.432	-0.127	0.321	0.711
Liability	0.164	0.253	0.135	-0.018	0.022	0.203	1	0.549	0.1	0.017	0.17	0.309
Med Mal	0.102	0.51	-0.087	-0.145	-0.146	-0.064	0.549	1	0.363	0.193	0.41	0.176
Other Comm	0.46	0.402	0.357	0.143	0.304	0.432	0.1	0.363	1	0.138	0.214	0.51
Personal Auto	0.089	0.522	0.078	-0.342	0.083	-0.127	0.017	0.193	0.138	1	0.107	0.349
Workers Comp	0.379	0.148	0.117	-0.131	0.332	0.321	0.17	0.41	0.214	0.107	1	0.427
total	0.892	0.423	0.769	0.264	0.858	0.711	0.309	0.176	0.51	0.349	0.427	1

Table 8: Pearson correlation between annual change in direct losses, by major line.

name	CMP	Comm Auto	Comm Property	Fin Guaranty	Home-owners	Inland Marine	Liability	Med Mal	Other Comm	Personal Auto	Reinsur-ance	Workers Comp	total
CMP	1	0.172	0.666	0.373	0.812	0.665	0.381	0.214	0.25	-0.097	0.547	0.408	0.788
Comm Auto	0.172	1	-0.005	-0.329	0.040	0.022	0.241	0.317	0.38	0.493	0.198	0.082	0.361
Comm Property	0.666	-0.005	1	0.283	0.627	0.545	0.071	-0.147	0.121	-0.063	0.577	-0.049	0.609
Fin Guaranty	0.373	-0.329	0.283	1	0.44	0.588	0.116	-0.100	0.061	-0.385	0.097	-0.104	0.27
Homeowners	0.812	0.040	0.627	0.44	1	0.671	0.325	0.003	0.178	-0.005	0.544	0.366	0.817
Inland Marine	0.665	0.022	0.545	0.588	0.671	1	0.365	-0.119	0.256	-0.197	0.491	0.179	0.578
Liability	0.381	0.241	0.071	0.116	0.325	0.365	1	0.299	0.325	-0.028	0.46	0.18	0.464
Med Mal	0.214	0.317	-0.147	-0.100	0.003	-0.119	0.299	1	0.272	0.112	-0.100	0.451	0.208
Other Comm	0.25	0.38	0.121	0.061	0.178	0.256	0.325	0.272	1	0.346	0.304	0.044	0.479
Personal Auto	-0.097	0.493	-0.063	-0.385	-0.005	-0.197	-0.028	0.112	0.346	1	-0.087	0.122	0.358
Reinsurance	0.547	0.198	0.577	0.097	0.544	0.491	0.46	-0.100	0.304	-0.087	1	0.002	0.602
Workers Comp	0.408	0.082	-0.049	-0.104	0.366	0.179	0.18	0.451	0.044	0.122	0.002	1	0.401
total	0.788	0.361	0.609	0.27	0.817	0.578	0.464	0.208	0.479	0.358	0.602	0.401	1

Table 9: Pearson correlation between annual change in net losses, by major line.

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Correlation Between Annual Change in Premium, by Major Line

name	CMP	Comm Auto	Comm Property	Fin Guaranty	Home-owners	Inland Marine	Liability	Med Mal	Other Comm	Personal Auto	Workers Comp	total
CMP	1	0.739	0.742	0.142	0.661	0.762	0.746	0.79	0.024	0.502	0.574	0.909
Comm Auto	0.739	1	0.429	0.019	0.277	0.701	0.634	0.516	0.066	0.672	0.453	0.839
Comm Property	0.742	0.429	1	0.174	0.396	0.501	0.608	0.775	0.181	0.207	0.153	0.649
Fin Guaranty	0.142	0.019	0.174	1	0.279	0.093	0.057	0.127	0.325	0.205	-0.091	0.212
Homeowners	0.661	0.277	0.396	0.279	1	0.289	0.48	0.568	-0.148	0.373	0.361	0.599
Inland Marine	0.762	0.701	0.501	0.093	0.289	1	0.487	0.528	0.2	0.468	0.553	0.749
Liability	0.746	0.634	0.608	0.057	0.48	0.487	1	0.565	-0.074	0.322	0.462	0.79
Med Mal	0.79	0.516	0.775	0.127	0.568	0.528	0.565	1	0.103	0.468	0.266	0.744
Other Comm	0.024	0.066	0.181	0.325	-0.148	0.2	-0.074	0.103	1	0.071	-0.128	0.16
Personal Auto	0.502	0.672	0.207	0.205	0.373	0.468	0.322	0.468	0.071	1	0.264	0.704
Workers Comp	0.574	0.453	0.153	-0.091	0.361	0.553	0.462	0.266	-0.128	0.264	1	0.598
total	0.909	0.839	0.649	0.212	0.599	0.749	0.79	0.744	0.16	0.704	0.598	1

Table 10: Pearson correlation between annual change in direct premium, by major line.

name	CMP	Comm Auto	Comm Property	Fin Guaranty	Home-owners	Inland Marine	Liability	Med Mal	Other Comm	Personal Auto	Reinsur-ance	Workers Comp	total
CMP	1	0.696	0.701	0.118	0.752	0.519	0.462	0.717	-0.014	0.506	0.256	0.645	0.881
Comm Auto	0.696	1	0.357	-0.013	0.406	0.576	0.334	0.412	0.226	0.675	0.025	0.526	0.813
Comm Property	0.701	0.357	1	0.186	0.549	0.398	0.488	0.685	-0.088	0.301	0.299	0.248	0.648
Fin Guaranty	0.118	-0.013	0.186	1	0.25	0.221	0.536	0.082	0.18	0.254	-0.017	-0.045	0.18
Homeowners	0.752	0.406	0.549	0.25	1	0.354	0.373	0.576	-0.184	0.48	-0.092	0.571	0.676
Inland Marine	0.519	0.576	0.398	0.221	0.354	1	0.439	0.483	0.207	0.458	0.315	0.434	0.676
Liability	0.462	0.334	0.488	0.536	0.373	0.439	1	0.421	0.028	0.349	0.341	0.249	0.559
Med Mal	0.717	0.412	0.685	0.082	0.576	0.483	0.421	1	0.028	0.347	0.569	0.397	0.724
Other Comm	-0.014	0.226	-0.088	0.18	-0.184	0.207	0.028	0.028	1	-0.002	0.034	-0.127	0.125
Personal Auto	0.506	0.675	0.301	0.254	0.48	0.458	0.349	0.347	-0.002	1	-0.077	0.44	0.754
Reinsurance	0.256	0.025	0.299	-0.017	-0.092	0.315	0.341	0.569	0.034	-0.077	1	0.054	0.288
Workers Comp	0.645	0.526	0.248	-0.045	0.571	0.434	0.249	0.397	-0.127	0.44	0.054	1	0.663
total	0.881	0.813	0.648	0.18	0.676	0.676	0.559	0.724	0.125	0.754	0.288	0.663	1

Table 11: Pearson correlation between annual change in net premium, by major line.

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Direct Loss Ratio Statistics by Major Line of Business

index	CMP	Comm Auto	Comm Property	Fin Guaranty	Home-owners	Inland Marine	Liability	Med Mal	Other Comm	Personal Auto	Workers Comp	total
min	0.543	0.624	0.365	-0.0027	0.565	0.393	0.678	0.548	0.522	0.663	0.577	0.639
mean	0.717	0.752	0.692	0.61	0.763	0.55	0.853	0.837	0.648	0.769	0.767	0.752
max	0.964	0.897	1.59	3.21	1.33	0.74	1.24	1.34	0.853	0.853	0.993	0.921
sd	0.107	0.0794	0.309	0.706	0.161	0.0806	0.159	0.211	0.0721	0.0403	0.108	0.0643
cv	0.149	0.106	0.446	1.16	0.21	0.146	0.186	0.252	0.111	0.0524	0.141	0.0856
growth	-165.617u	0.00214	0.121	0.167	0.00654	0.0143	-0.00624	-0.00433	-769.683u	0.00142	-0.0116	-0.00333
r2	0.248	0.00179	0.0701	0.0053	0.149	0.0328	0.547	0.25	0.14	0.013	0.365	0.334
rse0	0.0944	0.0807	0.303	0.717	0.151	0.0807	0.109	0.186	0.068	0.0407	0.088	0.0534
rse	0.0964	0.0824	0.309	0.732	0.154	0.0824	0.111	0.19	0.0695	0.0416	0.0898	0.0546
slope	-0.00606	-381.172u	-0.00928	0.00584	-0.00704	-0.00166	-0.0134	-0.012	-0.00306	-522.507u	-0.00744	-0.00422
year	12.87	1.52	19.31	-11.10	14.90	3.88	27.65	24.87	6.79	1.82	15.70	9.23
ar r2	0.263	0.78	6.069u	0.468	0.00902	0.0041	0.665	0.789	0.248	0.299	0.712	0.23
ar rse0	0.0862	0.0385	0.317	0.533	0.124	0.0811	0.0938	0.0976	0.0639	0.0349	0.0578	0.0539
ar rse	0.236	0.129	0.508	0.675	0.267	0.268	0.205	0.184	0.231	0.196	0.16	0.21
ar slope	0.464	0.883	0.00244	0.692	0.0709	-0.0623	0.81	0.866	0.498	0.547	0.84	0.443
ar intercept	0.376	0.0888	0.682	0.181	0.69	0.581	0.153	0.103	0.322	0.348	0.113	0.414

Table 12: Direct calendar year Loss ratio statistics by major line of business. See below for gloss.

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Net Loss Ratio Statistics by Major Line of Business

index	CMP	Comm Auto	Comm Property	Fin Guaranty	Home-owners	Inland Marine	Liability	Med Mal	Other Comm	Personal Auto	Reinsur-ance	Workers Comp	total
min	0.568	0.633	0.387	-0.0139	0.589	0.451	0.623	0.574	0.575	0.662	0.374	0.582	0.653
mean	0.717	0.749	0.677	0.606	0.765	0.568	0.83	0.834	0.65	0.766	0.813	0.762	0.752
max	0.895	0.873	1.33	2.77	1.24	0.658	1.17	1.32	0.787	0.838	2.05	0.971	0.884
sd	0.0869	0.0716	0.185	0.627	0.128	0.0587	0.157	0.197	0.0529	0.0393	0.312	0.103	0.0559
cv	0.121	0.0956	0.273	1.04	0.168	0.103	0.189	0.236	0.0814	0.0513	0.384	0.135	0.0744
growth	-0.00316	743.787u	0.0486	0.174	-0.00518	0.00322	-0.00429	-0.00238	-0.00162	0.00131	0.0578	-0.0137	-0.00452
r2	0.35	0.0036	0.0521	0.0021	0.25	0.119	0.472	0.2	0.329	0.0462	0.072	0.328	0.392
rse0	0.0713	0.0728	0.183	0.638	0.113	0.0561	0.116	0.179	0.0441	0.0391	0.306	0.0855	0.0444
rse	0.0728	0.0743	0.187	0.651	0.116	0.0573	0.118	0.183	0.045	0.0399	0.313	0.0874	0.0453
slope	-0.00584	-488.462u	-0.00479	0.00327	-0.0073	-0.0023	-0.0122	-0.00999	-0.00345	-959.237u	-0.00952	-0.00667	-0.00398
year	12.43	1.73	10.29	-5.95	15.41	5.18	25.36	20.87	7.56	2.69	19.92	14.14	8.73
ar r2	0.466	0.747	0.0146	0.435	0.125	0.0267	0.48	0.73	0.664	0.288	0.0597	0.71	0.369
ar rse0	0.0606	0.0374	0.189	0.489	0.0887	0.0587	0.113	0.103	0.0315	0.0342	0.312	0.0528	0.0414
ar rse	0.19	0.134	0.378	0.636	0.217	0.245	0.247	0.2	0.142	0.197	0.498	0.153	0.179
ar slope	0.63	0.865	0.12	0.671	0.252	0.161	0.672	0.832	0.807	0.537	0.243	0.811	0.549
ar intercept	0.26	0.101	0.591	0.187	0.556	0.474	0.262	0.131	0.124	0.354	0.609	0.132	0.334

Table 13: Net calendar year Loss ratio statistics by major line of business. See below for gloss.

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Loss Ratio Statistics by Major Line of Business

Key

- `min`, `mean`, `max`, `sd`, and `cv` are the minimum, mean, maximum, standard deviation and coefficient of variation of loss ratio
- `growth` is the arithmetic average annual growth rate
- `r2`, `rse0`, `slope`, and `year` are the R^2, residual standard error, slope coefficient and year (time) coefficient for a regression of loss ratio against time; `rse` equals `rse0` plus the standard error of the slope parameter
- `ar r2`, `ar rse0`, `ar intercept`, and `ar slope` are the R^2, residual standard error, slope coefficient and year (time) coefficient for an autoregression with lag 1; `ar rse` equals `ar rse0` plus the standard error of the auto regressive parameter

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Direct Loss Ratio Time Series by Major Line

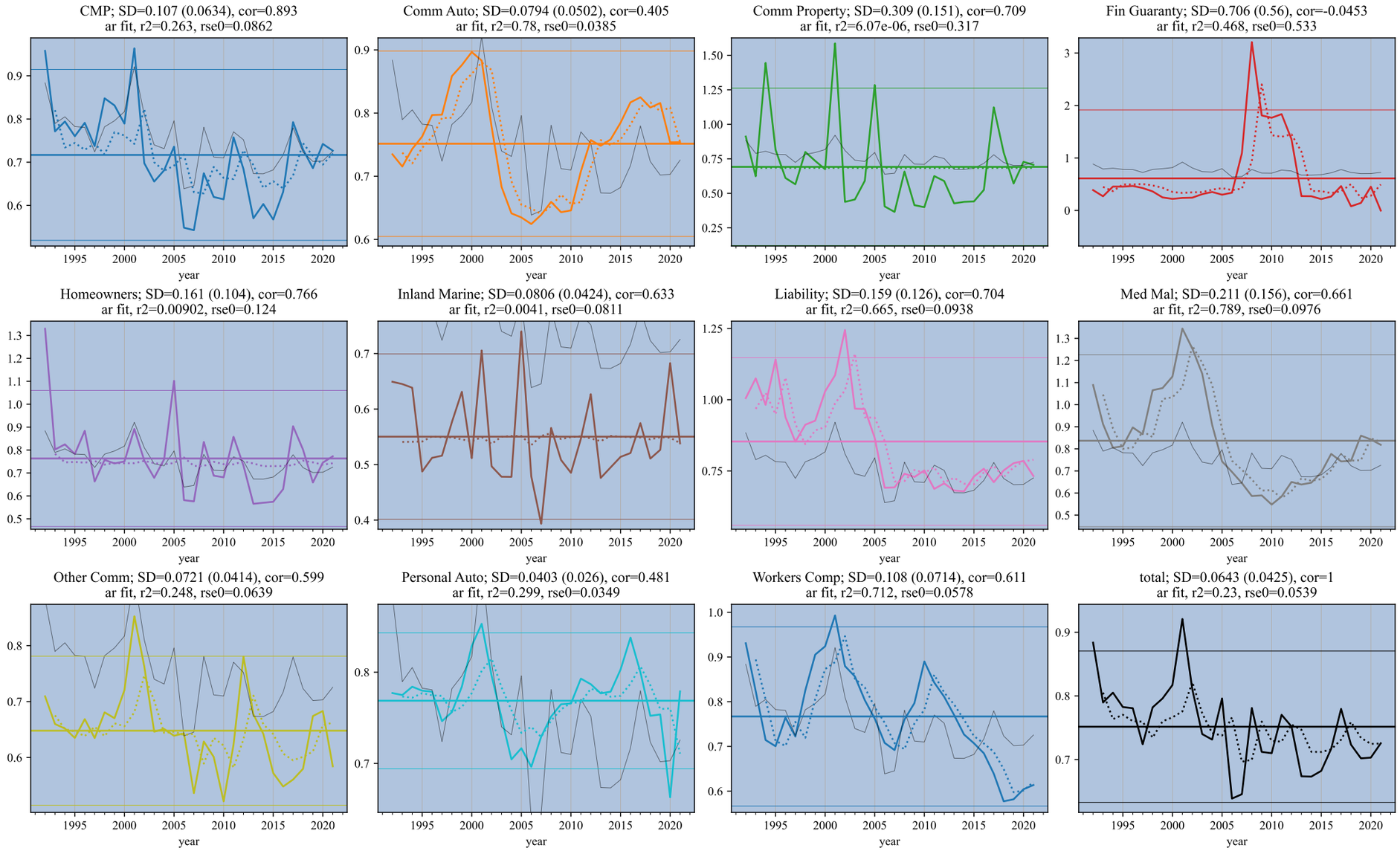

Figure 18: Direct calendar year Loss ratio time series by major line. See gloss below.

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Net Loss Ratio Time Series by Major Line

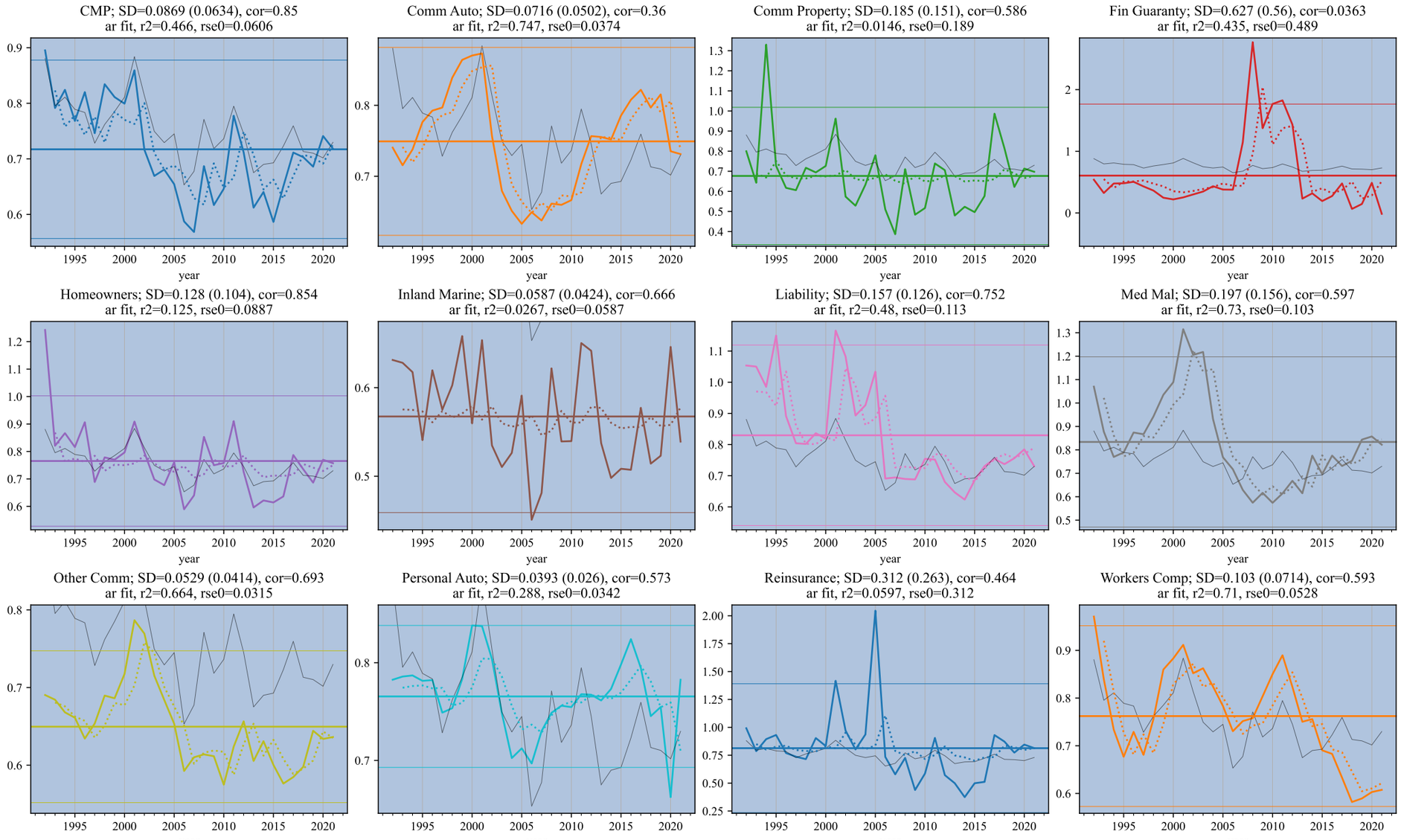

Figure 19: Net calendar year Loss ratio time series by major line. See gloss on next slide.

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Loss Ratio Time Series by Major Line

Title decoder: `CMP; SD=0.107 (0.0634), cor=0.893 ar fit, r2=0.263, rse0=0.0862`

- Line; standard deviation
- Down-side semi-deviation is shown in parenthesis (explain)
- Correlation of the line with total on the first line
- (second line) shows the R^2 and residual standard error of an autoregressive loss ratio model

Interpretation

- When the `rse` is much lower than `SD` it suggests the market cycle is predictable
- Tends to occur in casualty lines (e.g., commercial auto, medical malpractice, private passenger auto, and workers compensation)
- The cycle for property lines tends to be idiosyncratic, for obvious reasons.

Line Legend

- Thin gray line in each plot shows the `total` loss ratio, for context
- The horizontal lines show the mean (thicker) and mean $\pm\Phi^{-1}(30/31) = \pm 1.85$ standard deviations
  - If the loss ratios were normally distributed we expect all observations from 22 years (1996-2017) to fall within these tram lines
  - They provide a surprisingly good estimate of the range of loss ratio, except for `Financial Lines` (which uses a different tick spacing, note).

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Total Loss Ratio Time Series, Direct and Net

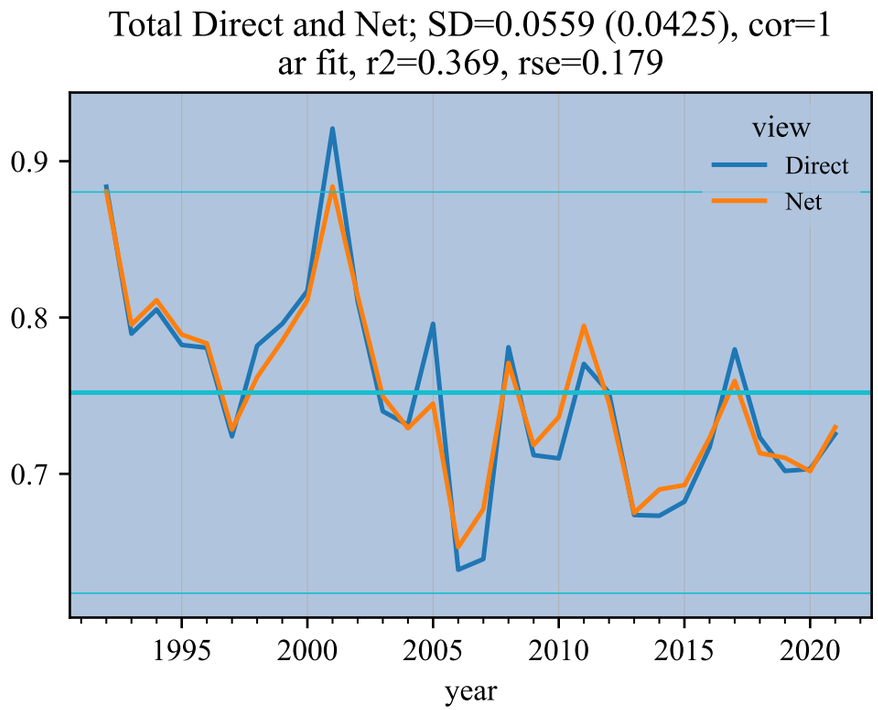

Figure 20: Average direct loss ratio is 0.752 with standard deviation 0.064. Average net loss ratio is 0.752 with standard deviation 0.056. Remember gross equals direct plus assumed minus ceded, so the difference between direct and net is not the same as ceded.

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Direct Loss Ratio Time Series by Major Line, Loss Ratio Scale 0 to 150 Percent

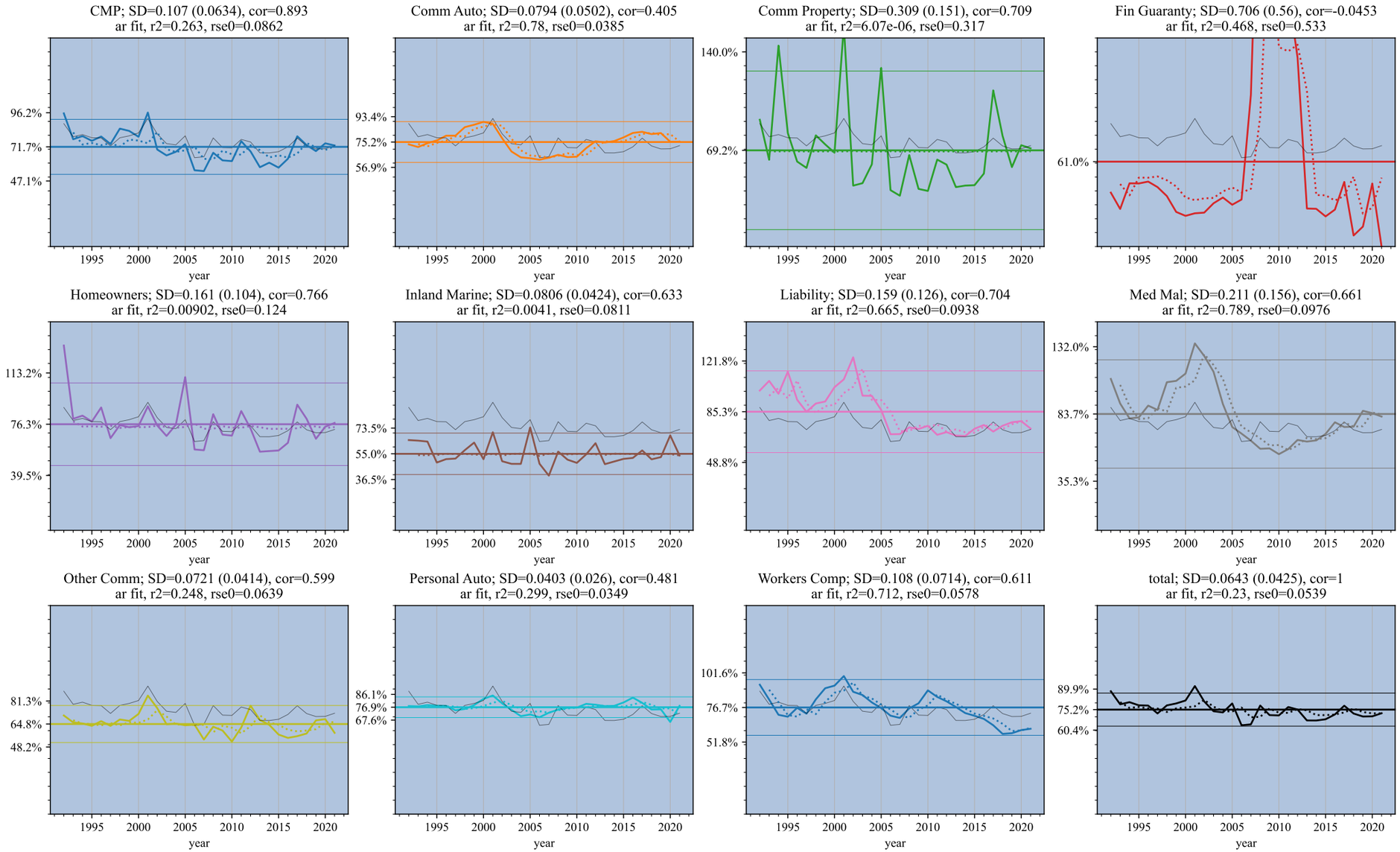

Figure 21: Same as the previous plot, but using the same *y* axis scale on all plots, to emphasize inter-line behavior.

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Net Loss Ratio Time Series by Major Line, Loss Ratio Scale 0 to 150 Percent

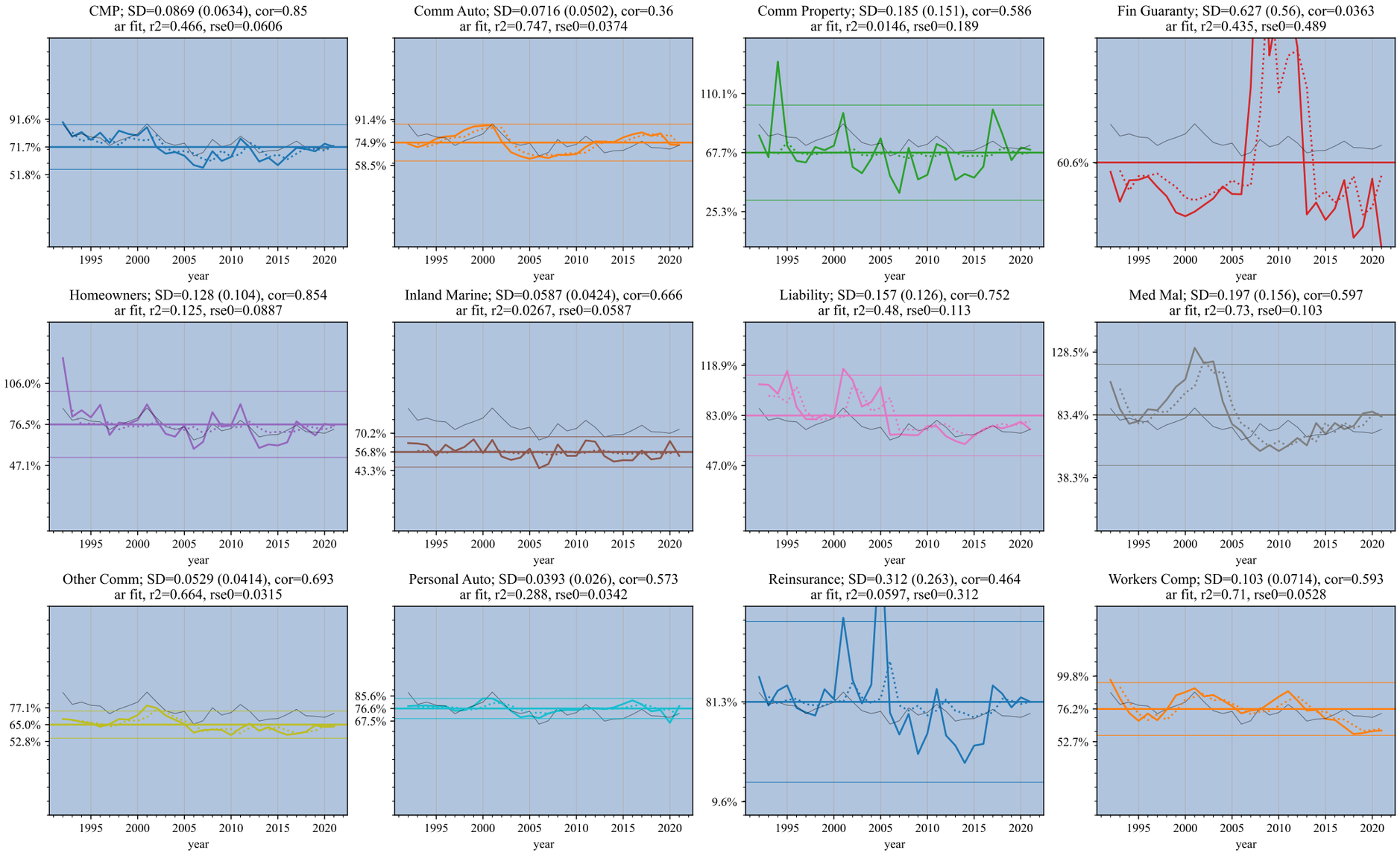

Figure 22: Same as the previous plot, but using the same *y* axis scale on all plots, to emphasize inter-line behavior.

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Some Lines Are More Volatile Than Others...

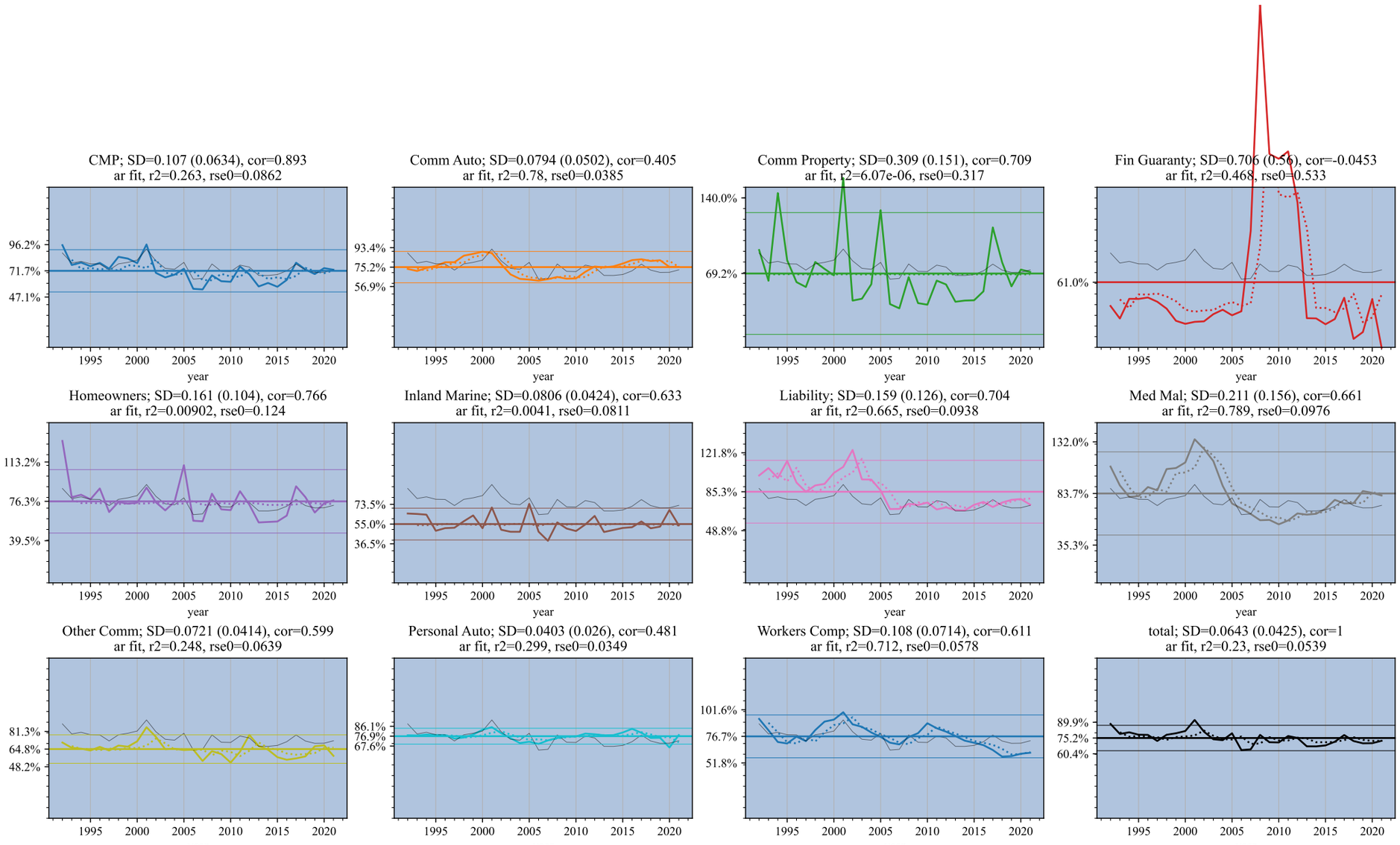

Figure 23: Same as the previous plot, but not clipping loss ratios at 150 percent for Commercial Property, Liability and Fin Guaranty.

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Reinsurance More Effective for Some Lines Than Others. . .

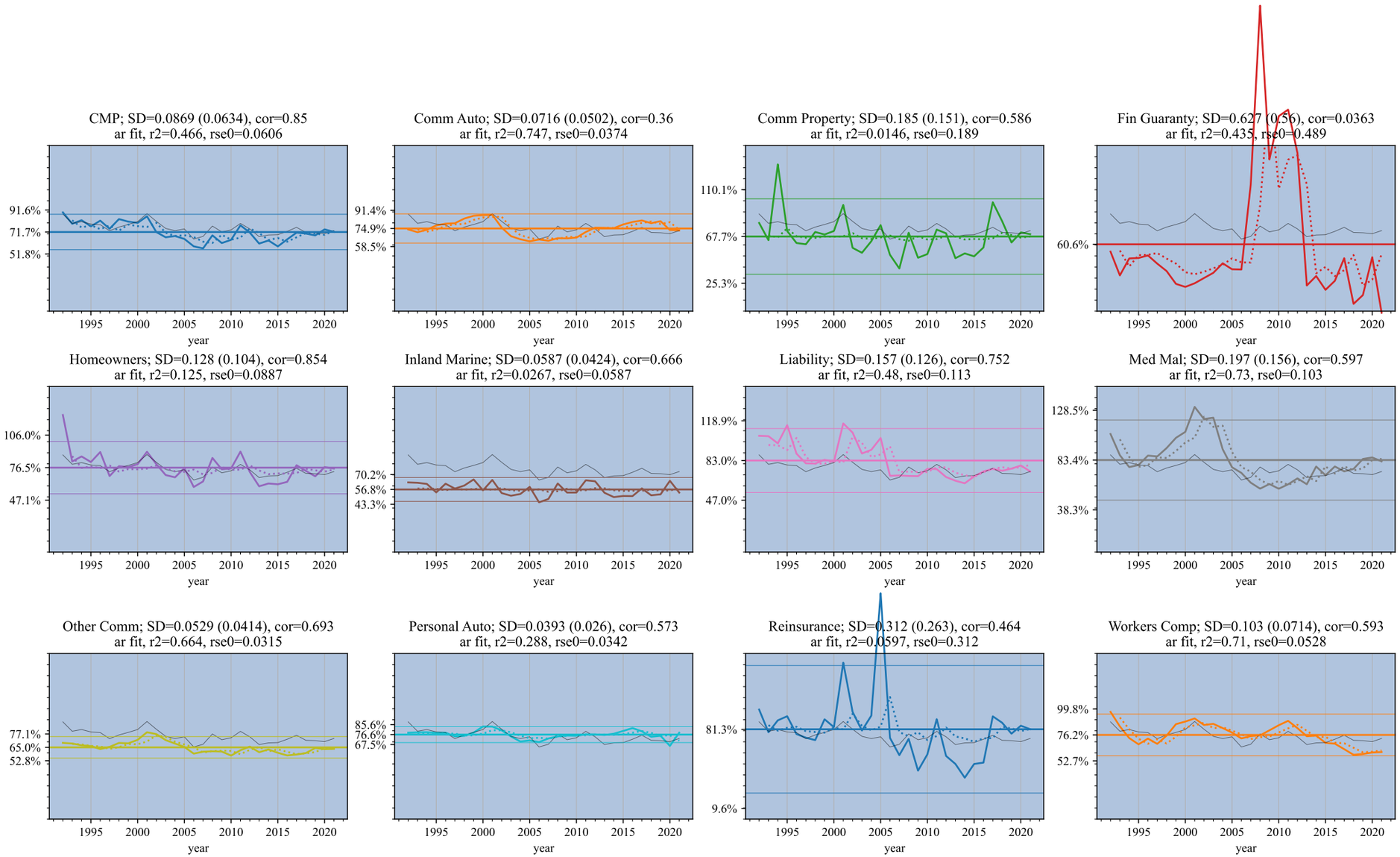

Figure 24: Reinsurance on Commercial Property, typically excess, reduces volatility very effectively whereas net loss more volatile for liabiltiy lines, often protected with quota shares.

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Direct Premium and Loss Dynamics

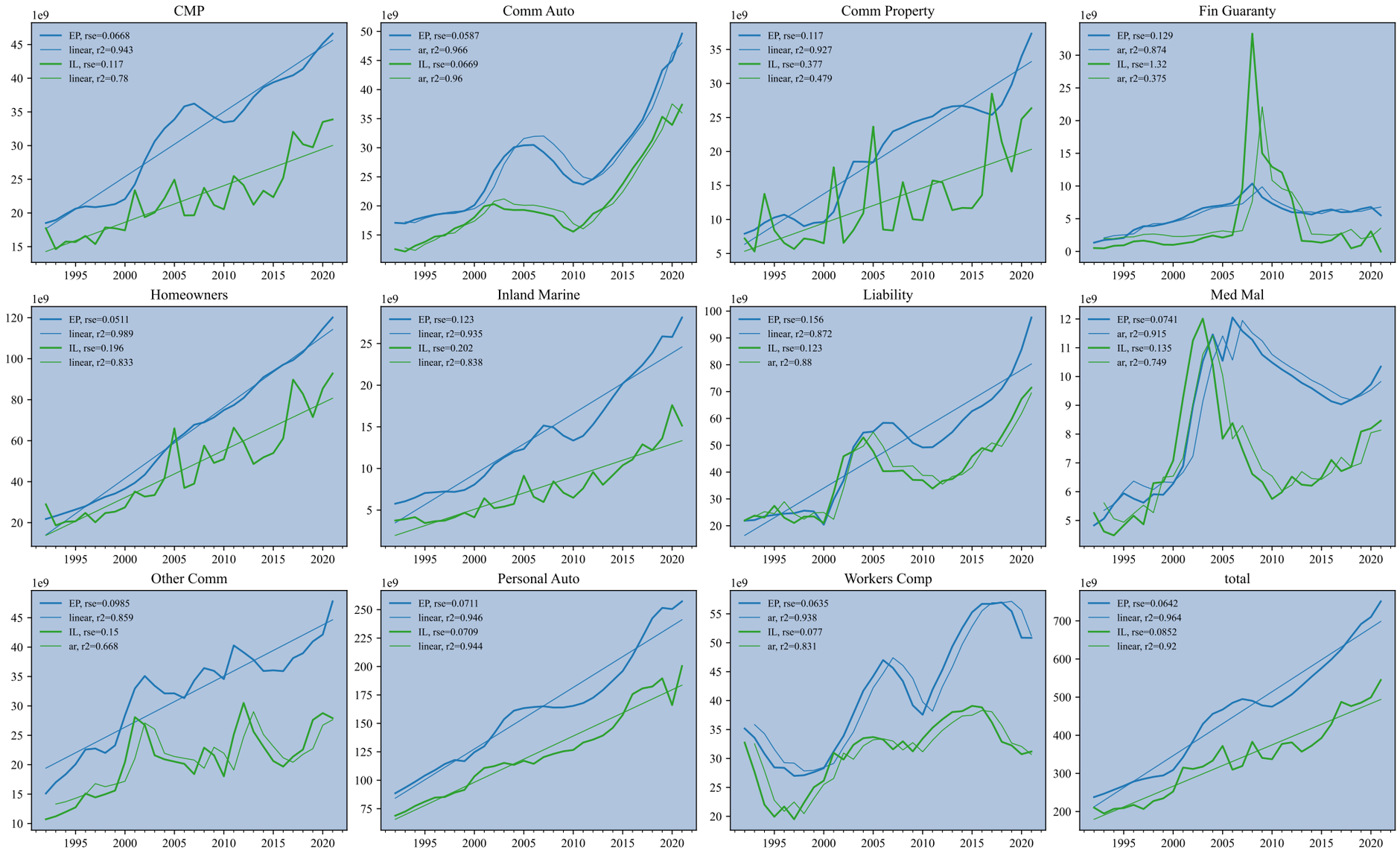

Figure 25: See below for gloss. `rse` is residual standard error without parameter uncertainty, normalized by the mean.

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Net Premium and Loss Dynamics

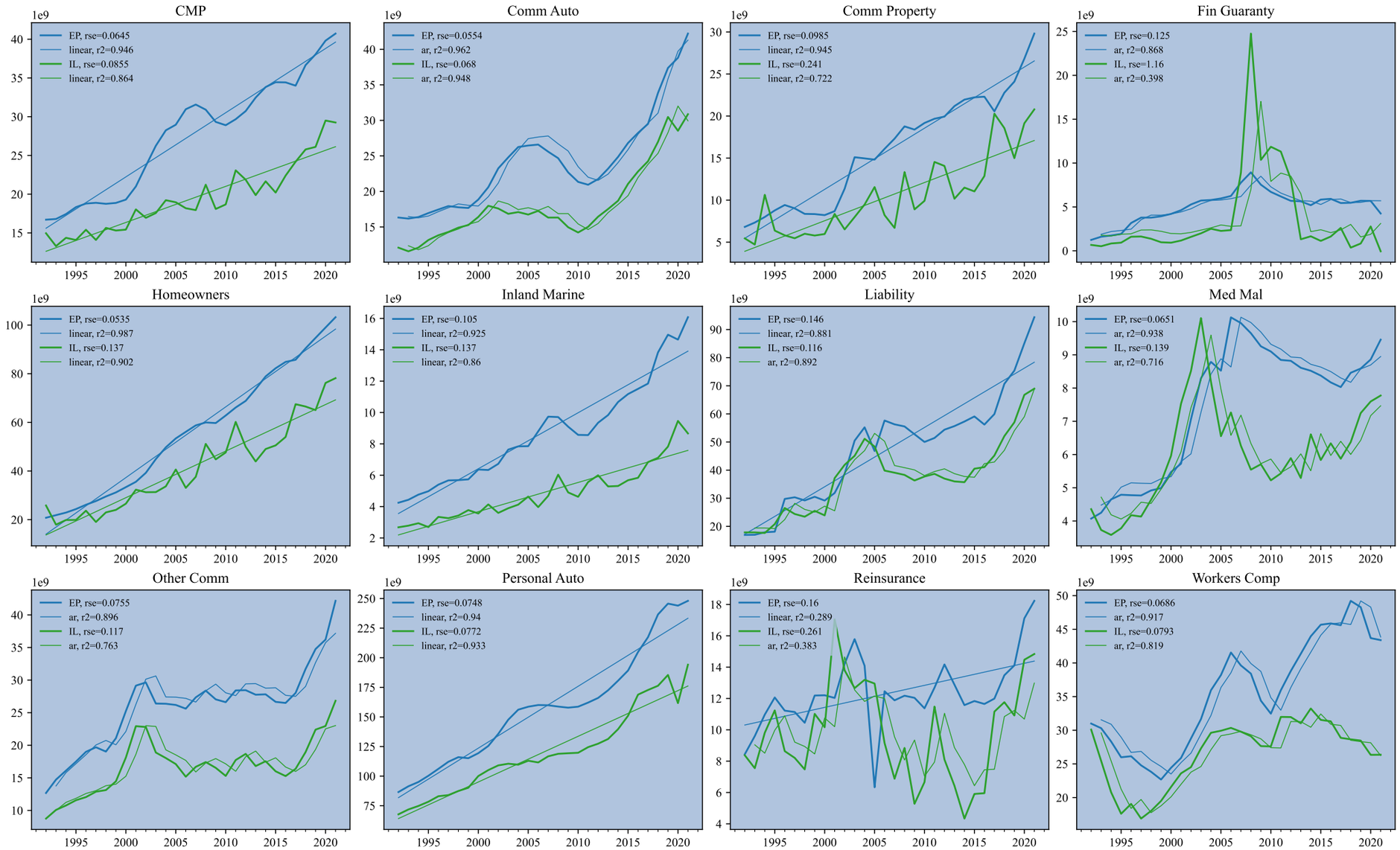

Figure 26: See below for gloss. `rse` is residual standard error without parameter uncertainty, normalized by the mean.

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Direct Premium and Loss Dynamics

	CMP		Comm Auto		Comm Property		Fin Guaranty		Home-owners		Inland Marine	
index	EP	IL	EP	IL	EP	IL	EP	IL	EP	IL	EP	IL
cv	0.276	0.244	0.314	0.332	0.428	0.513	0.378	1.623	0.477	0.471	0.473	0.494
cvlr	0.147	0.147	0.104	0.104	0.439	0.439	1.137	1.137	0.207	0.207	0.144	0.144
r2	0.943	0.780	0.746	0.708	0.927	0.479	0.401	0.021	0.989	0.833	0.935	0.838
rse	0.067	0.117	0.161	0.182	0.117	0.377	0.298	1.635	0.051	0.196	0.123	0.202
ar r2	0.984	0.717	0.966	0.960	0.972	0.211	0.874	0.375	0.998	0.739	0.988	0.827
ar rse	0.034	0.133	0.059	0.067	0.072	0.466	0.129	1.322	0.021	0.246	0.052	0.209

	Liability		Med Mal		Other Comm		Personal Auto		Workers Comp		total	
index	EP	IL	EP	IL	EP	IL	EP	IL	EP	IL	EP	IL
cv	0.430	0.352	0.259	0.265	0.258	0.268	0.301	0.296	0.248	0.181	0.330	0.295
cvlr	0.183	0.183	0.248	0.248	0.109	0.109	0.052	0.052	0.139	0.139	0.084	0.084
r2	0.872	0.676	0.476	0.066	0.859	0.551	0.946	0.944	0.799	0.489	0.964	0.920
rse	0.156	0.204	0.191	0.261	0.099	0.183	0.071	0.071	0.113	0.132	0.064	0.085
ar r2	0.959	0.880	0.915	0.749	0.923	0.668	0.990	0.941	0.938	0.831	0.992	0.915
ar rse	0.087	0.123	0.074	0.135	0.069	0.150	0.030	0.072	0.063	0.077	0.030	0.087

Table 14: See below for gloss.

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Net Direct Premium and Loss Dynamics

	CMP		Comm Auto		Comm Property		Fin Guaranty		Home-owners		Inland Marine	
index	EP	IL	EP	IL	EP	IL	EP	IL	EP	IL	EP	IL
cv	0.272	0.228	0.283	0.294	0.411	0.448	0.362	1.446	0.459	0.428	0.374	0.361
cvlr	0.119	0.119	0.094	0.094	0.268	0.268	1.018	1.018	0.165	0.165	0.102	0.102
r2	0.946	0.864	0.733	0.697	0.945	0.722	0.396	0.023	0.987	0.902	0.925	0.860
rse	0.065	0.085	0.149	0.165	0.098	0.241	0.286	1.455	0.053	0.137	0.105	0.137
ar r2	0.980	0.838	0.962	0.948	0.967	0.581	0.868	0.398	0.997	0.878	0.972	0.867
ar rse	0.038	0.093	0.055	0.068	0.075	0.294	0.125	1.156	0.024	0.153	0.063	0.132

	Liability		Med Mal		Other Comm		Personal Auto		Reinsur-ance		Workers Comp	
index	EP	IL	EP	IL	EP	IL	EP	IL	EP	IL	EP	IL
cv	0.414	0.354	0.266	0.258	0.245	0.248	0.301	0.293	0.187	0.322	0.231	0.182
cvlr	0.186	0.186	0.232	0.232	0.080	0.080	0.050	0.050	0.378	0.378	0.132	0.132
r2	0.881	0.680	0.637	0.217	0.750	0.452	0.940	0.933	0.289	0.000	0.768	0.395
rse	0.146	0.204	0.163	0.232	0.125	0.187	0.075	0.077	0.160	0.328	0.113	0.144
ar r2	0.932	0.892	0.938	0.716	0.896	0.763	0.988	0.939	0.228	0.383	0.917	0.819
ar rse	0.107	0.116	0.065	0.139	0.075	0.117	0.032	0.072	0.161	0.261	0.069	0.079

Table 15: See below for gloss.

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Premium and Loss Dynamics

- **Loss ratio** uncertainty combines **loss** uncertainty and **premium** uncertainty
  - Loss uncertainty = event risk, catastrophes, unexpected trends, estimation error, etc.
  - Premium uncertainty = market or cycle uncertainty; ability to charge technical rate in market
  - `rse` is residual standard error without parameter uncertainty
- Looking at premium and loss time series separately illuminates the particular dynamics of each line
- Each plot shows premium and loss time series (thicker) and a linear or AR(1) fit (thinner)
- Cat-driven loss dynamics stand-out for CMP, Comm Property, Homeowners, Other Commercial and to a lesser extent, Inland Marine
- Non-cat losses tend to be smoother, as events bleed in through development: Comm Auto and Workers Comp
- A priori expect premium in most lines to grow smoothly, approximately with GDP, as seen in Homeowners
- However, most lines exhibit excess premium volatility
  - Personal Auto and Workers Comp premium are more uncertain than loss as measured by regression residual standard error
  - Comm Auto premium exhibits huge cyclic behavior
- Loss ratio uncertainty is a multifaceted and subtle pheneomenon

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Calm Surface Masks Inner Turmoil

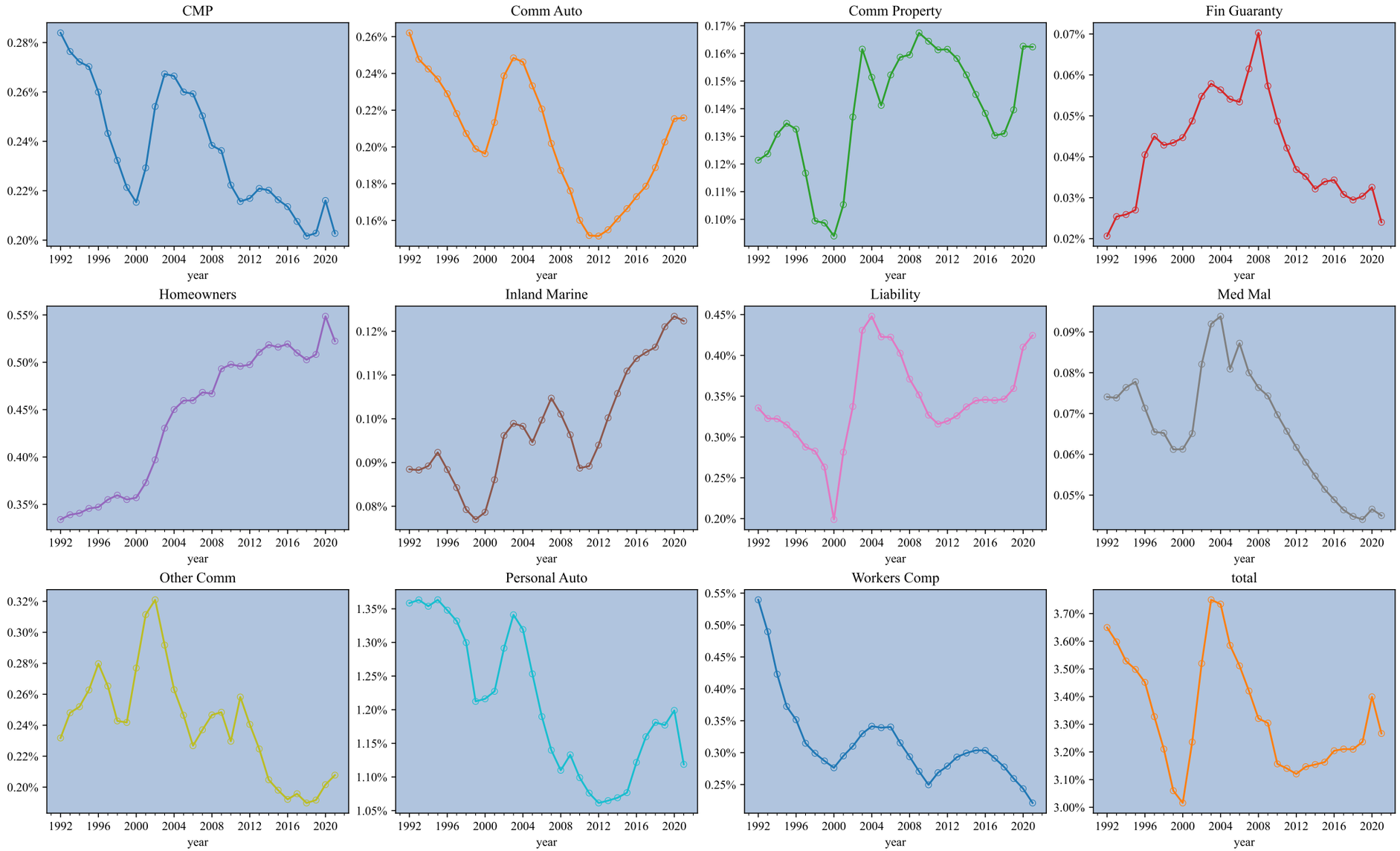

Figure 27: Direct premium to GDP by major line shows a wide variety of behaviors. Broadly, property has increased, while liability coverages have decreased.

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The Underwriting Cycle Is Driven by Commercial Lines

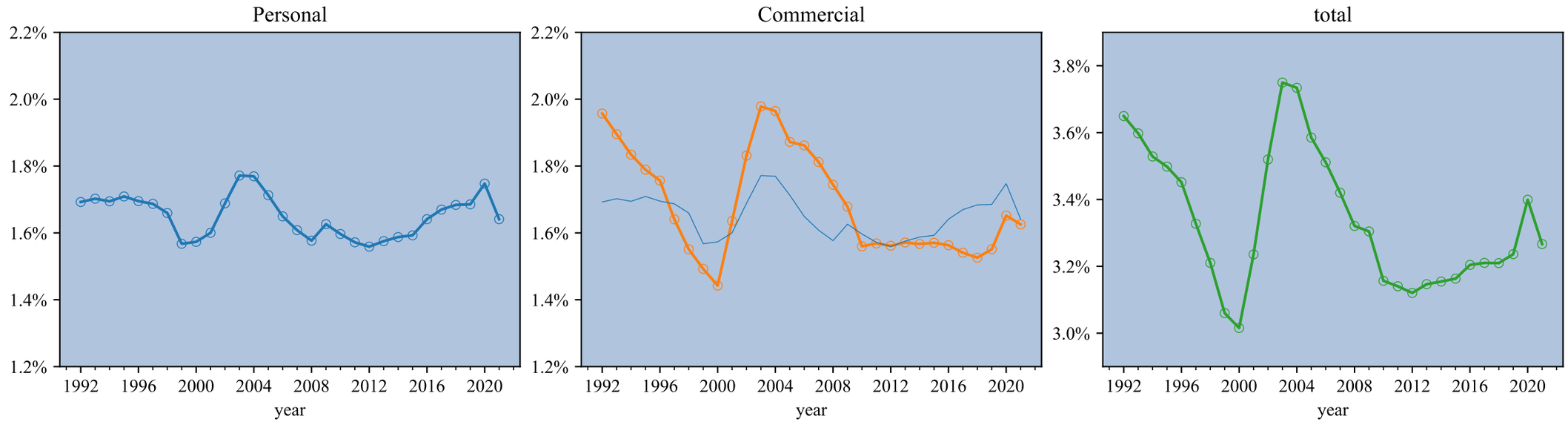

Figure 28: Premium to GDP for personal lines vs. commerical shows the cycle is more driven by commercial. All y axes have the same range but different locations. Personal lines (blue) shown on commerical plot to compare relative sizes. Commercial lines has been bigger than personal since 2001

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Direct and Net Premium and Loss

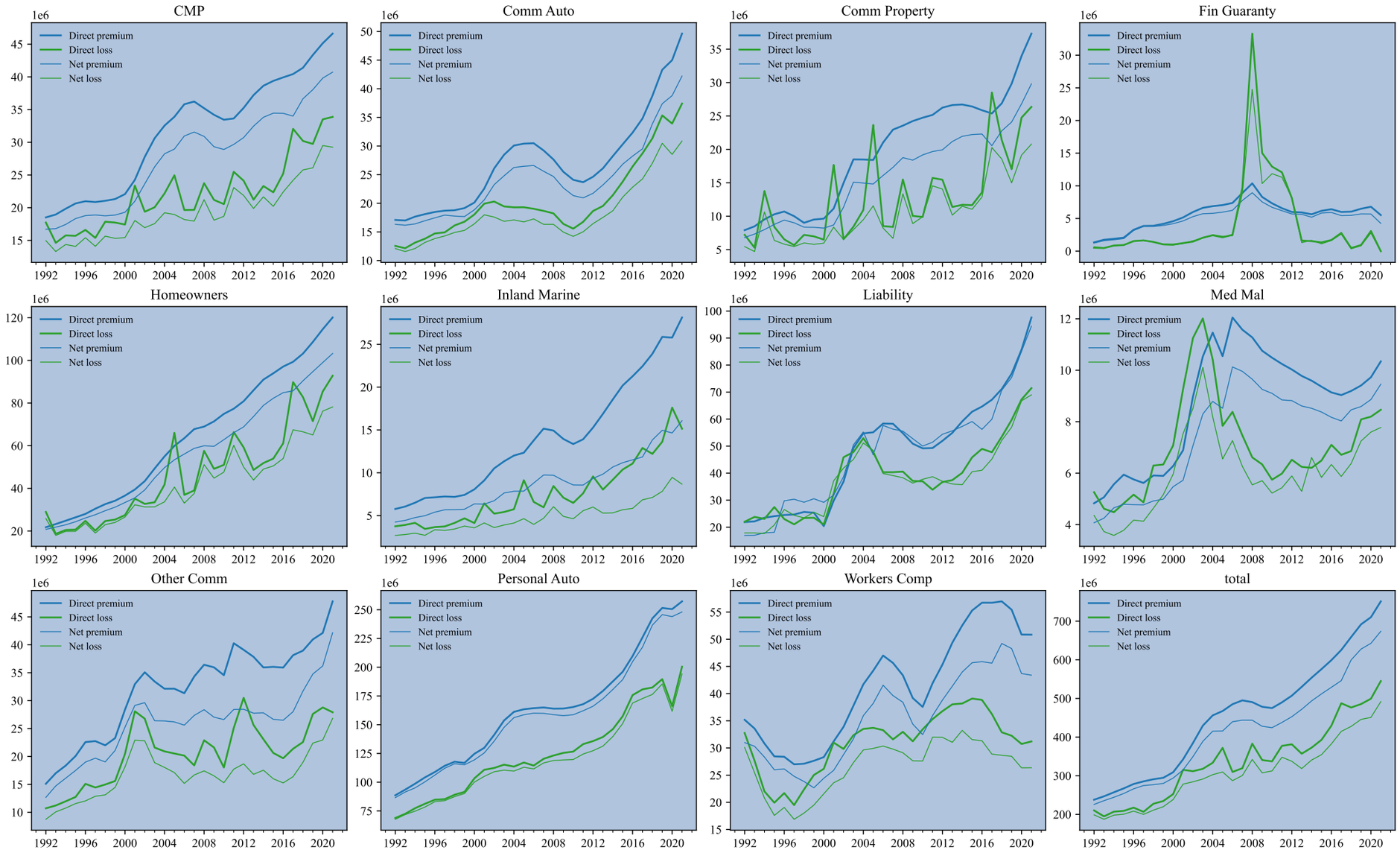

Figure 29: Direct and net premium and loss by major line.

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Direct and Net Combined Ratio and Loss Ratio by Line by Year

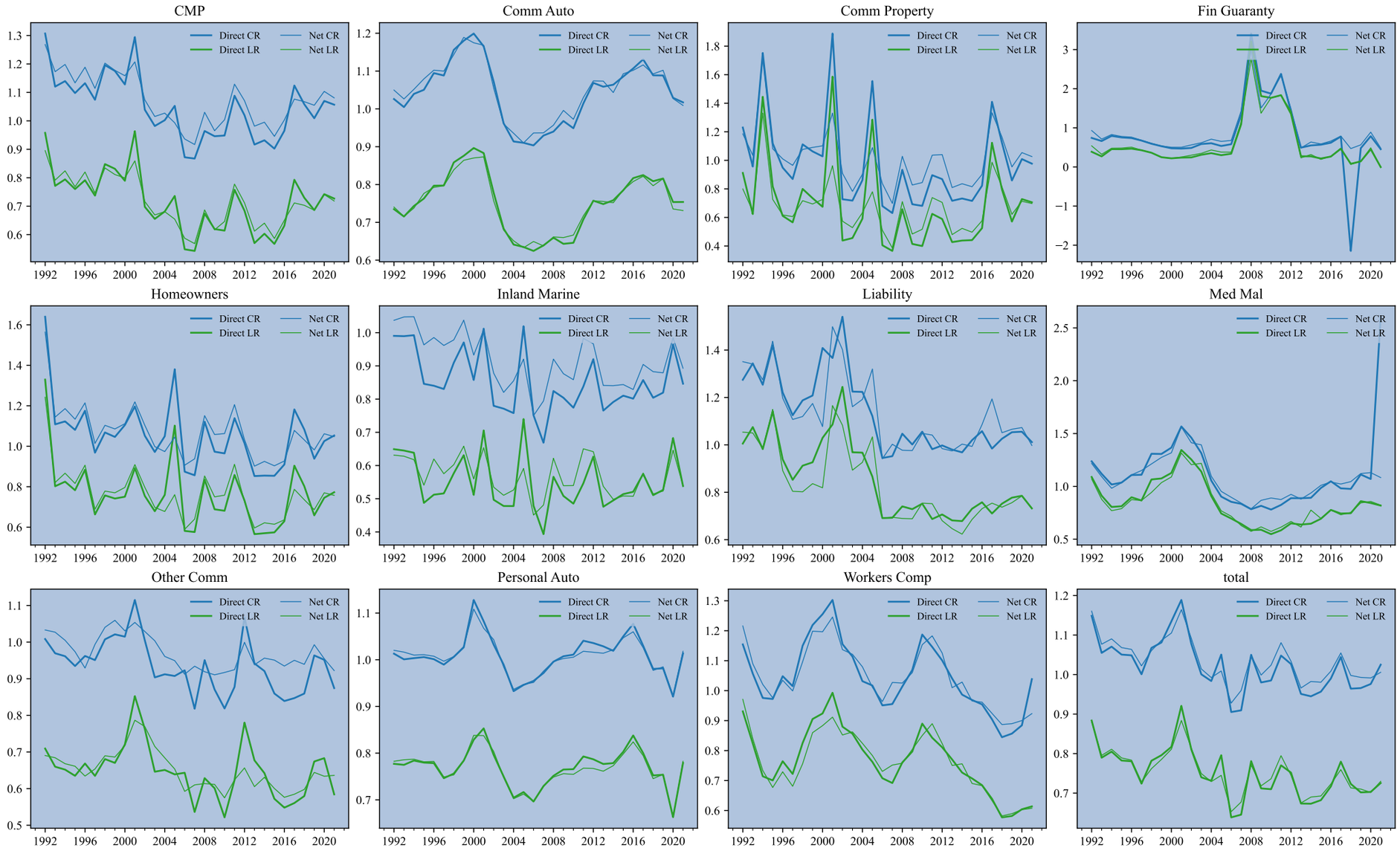

Figure 30: Direct and Net Combined Ratio and Loss Ratio by Line by Year.

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Net Operating Results

name	Avg UW Margin	Wtd Avg UW Margin	SD UW Margin	Avg Op Margin	Wtd Avg Op Margin	SD Op Margin	Avg II	MSD	Adj Op Margin
Med Mal	-0.072	-0.046	0.186	0.114	0.124	0.179	0.186	0.639	0.152
Inland Marine	0.083	0.097	0.080	0.105	0.118	0.079	0.023	1.338	0.157
Workers Comp	-0.048	-0.032	0.102	0.092	0.104	0.097	0.140	0.944	0.129
Fin Guaranty	0.091	-0.015	0.596	0.048	-0.092	1.036	-0.044	0.046	0.045
Liability	-0.135	-0.096	0.155	0.039	0.061	0.145	0.174	0.266	0.055
Personal Auto	-0.007	-0.004	0.039	0.026	0.027	0.039	0.034	0.668	0.034
total	-0.035	-0.024	0.056	0.025	0.030	0.059	0.061	0.433	0.035
Comm Property	-0.016	0.012	0.201	0.018	0.044	0.199	0.034	0.089	0.019
Reinsurance	-0.156	-0.129	0.365	0.015	0.035	0.335	0.171	0.045	-0.552
Comm Auto	-0.050	-0.046	0.076	0.010	0.011	0.071	0.061	0.145	0.014
Other Comm	0.028	0.033	0.047	0.001	-0.004	0.504	-0.028	0.002	-0.003
CMP	-0.076	-0.060	0.093	-0.009	0.002	0.078	0.067	-0.119	-0.016
Homeowners	-0.070	-0.039	0.133	-0.041	-0.013	0.127	0.030	-0.321	-0.060

Table 16: Insurance operating result, with allocated investment income from policyholder funds, by major line. Weighted `Wtd` average margins are higher than straight `Avg` averages because bad results are followed by increasing rates and volume, thus good years receive relatively greater weight. Weighted also biases towards the most recent year. The straight average is a more appropriate measure of average achieved profitability. Sorted by descending average operating margin, most profitable first. `Avg II` shows implied investment income. `MSD` shows (straight) average to standard deviation ratio for operating margin. `Adj Op Margin` shows the operating margin adjusted for average expenses in the line.

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Average Margins, All Lines Combined

Historical average margins

index	UW Margin	Op Margin	IEE Op Ins Funds	IEE Total Op	Inc Stmt Pre-Tax Total Return	Adj Op Margin
Average	-0.0356	0.0901	0.028	0.106	0.122	0.126
Wtd Avg	-0.0249	0.0942	0.0317	0.111	0.0881	0.131
Drag	0.0108	0.00411	0.00372	0.00499	-0.0341	0.00573

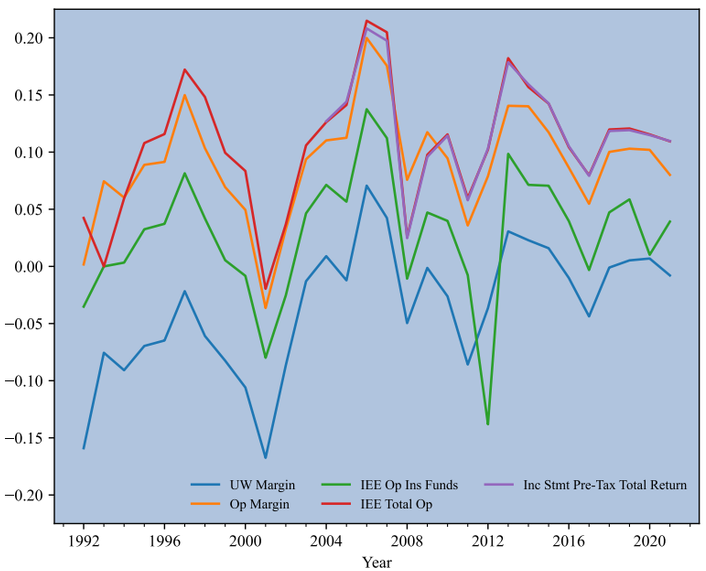

Figure 31: Average margins over time, all lines combined

Target average margins

- Table shows historical average pre-tax margin to earned premium
  - UU margin, with no investment income
  - Op margin, with income but no gains
  - IEE margin, with investment gains on insurance funds
  - IEE margin, with all invsetment gains
  - Income statement, with all gains
  - THe last two should be the same
- Weighted return greater than average because of cycle effect
- `Adj Op Margin` adjusts for expenses

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C.05. Direct Premium Growth by Major Line, 1992-2021

Average Direct Premium Growth Rates by Line (Percent)

index	Mean	SD	CAGR	Adj
Workers Comp	1.48	6.51	1.28	1.27
Med Mal	2.94	8.02	2.66	2.62
CMP	3.30	3.79	3.24	3.23
Personal Auto	3.78	2.85	3.75	3.74
Comm Auto	3.90	5.76	3.74	3.73
total	4.09	3.26	4.04	4.04
Other Comm	4.29	7.37	4.05	4.02
GDP	4.47	2.41	4.25	4.44
Inland Marine	5.74	5.17	5.62	5.61
Comm Property	5.84	8.94	5.49	5.44
Liability	5.91	12.13	5.29	5.17
Fin Guaranty	5.97	15.23	4.99	4.81
Homeowners	6.10	2.67	6.06	6.06

Table 17: Average direcet premium growth rates by line of business, with (nominal) GDP included for reference. Lines sorted from slowest to fastest growth. Insurance grows broadly with the economy, as the premium to GDP analysis showed. Since 1992, premium growth has slightly lagged GDP growth. `Mean` shows the average annual growth rate and `SD` its standard deviation. `CAGR` is the compound average growth rate. `Adj` shows the arithmetic mean adjusted for volatility using the lognormal $\mu + \sigma^2/2$ formula. It is very close to the actual compound rate. Source: GDP from FRED.

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Annual Change in Direct Premium by Line

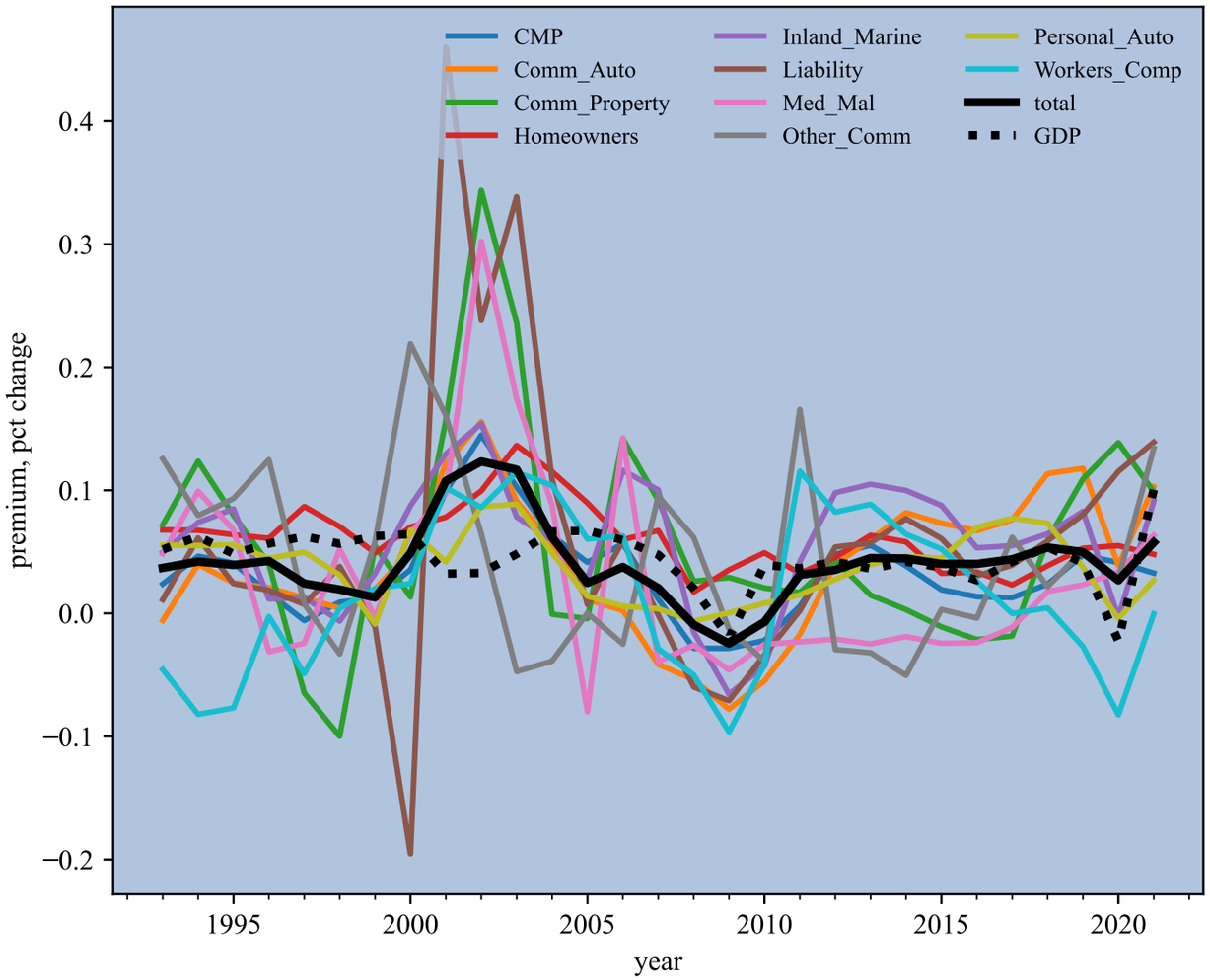

Figure 32: Change by line correlated to the economy (GDP), but displays considerable variation by line.

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Annual Change in Direct Premium Detailed by Line

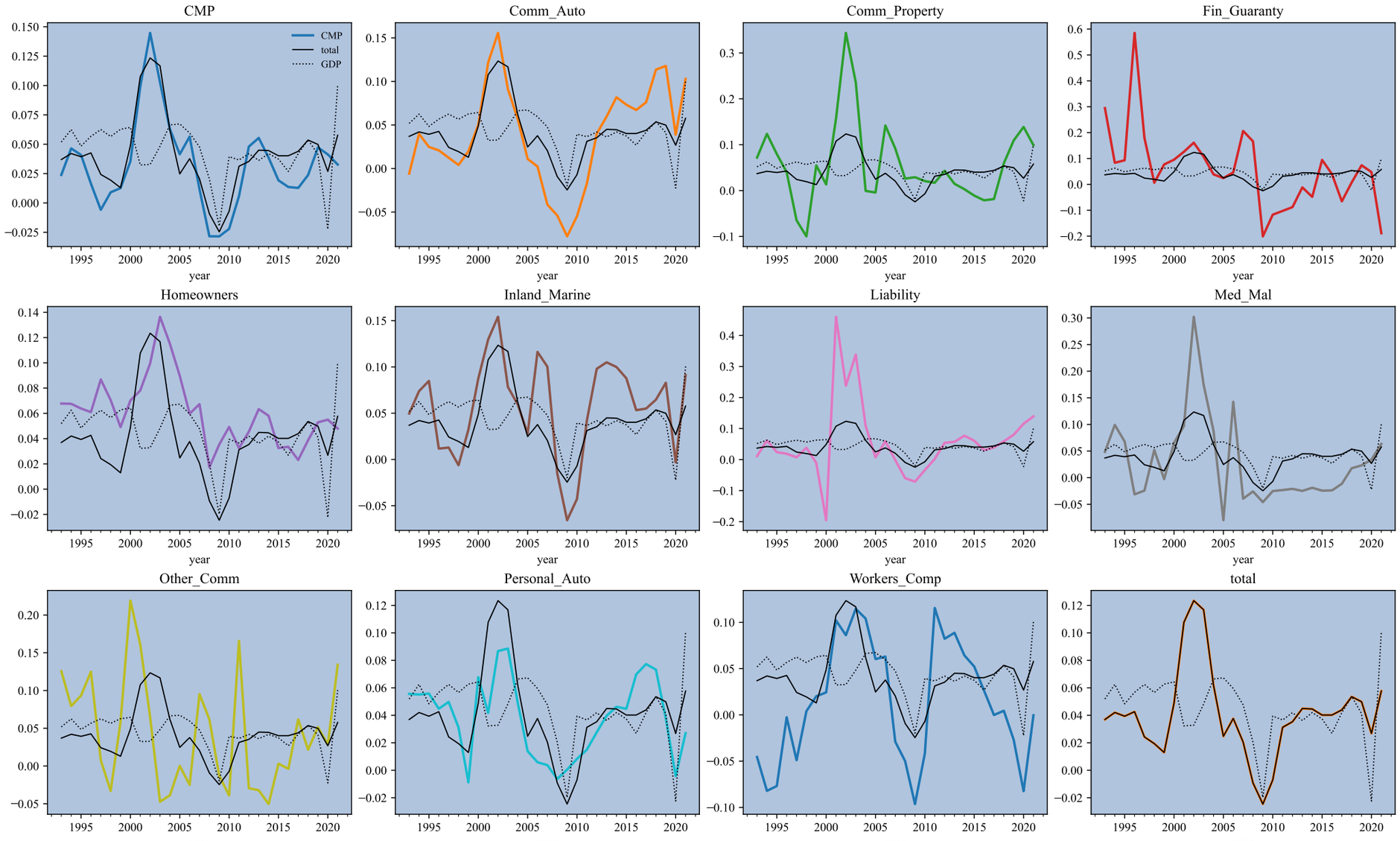

Figure 33: Degree of correlation to the economy (GDP) varies by line.

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Annual Change in Direct Premium by Line Common Scale

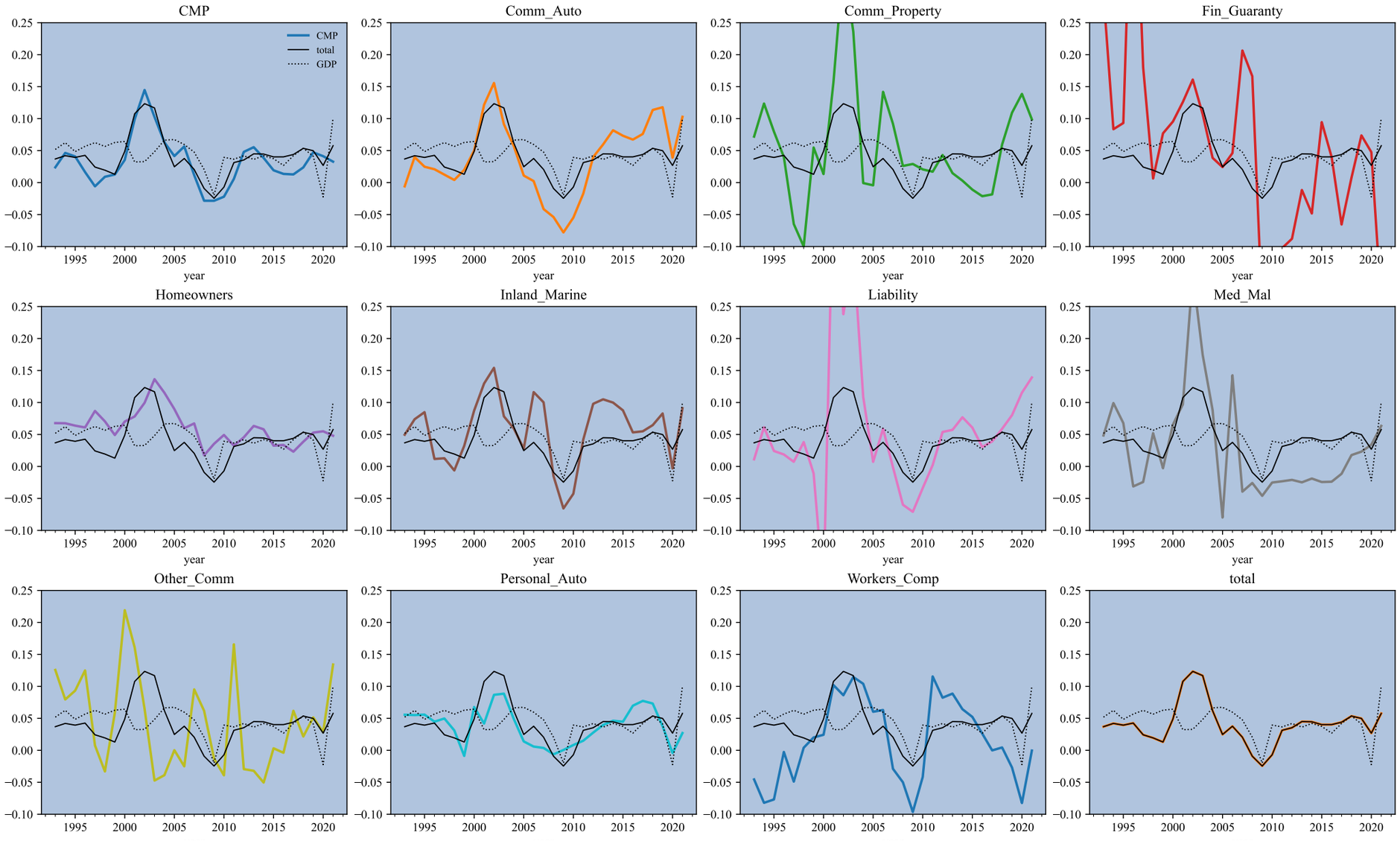

Figure 34: Magnitude of premium changes varies considerably by line.

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Premium and GDP Growth Since 1992 (1992=1.0)

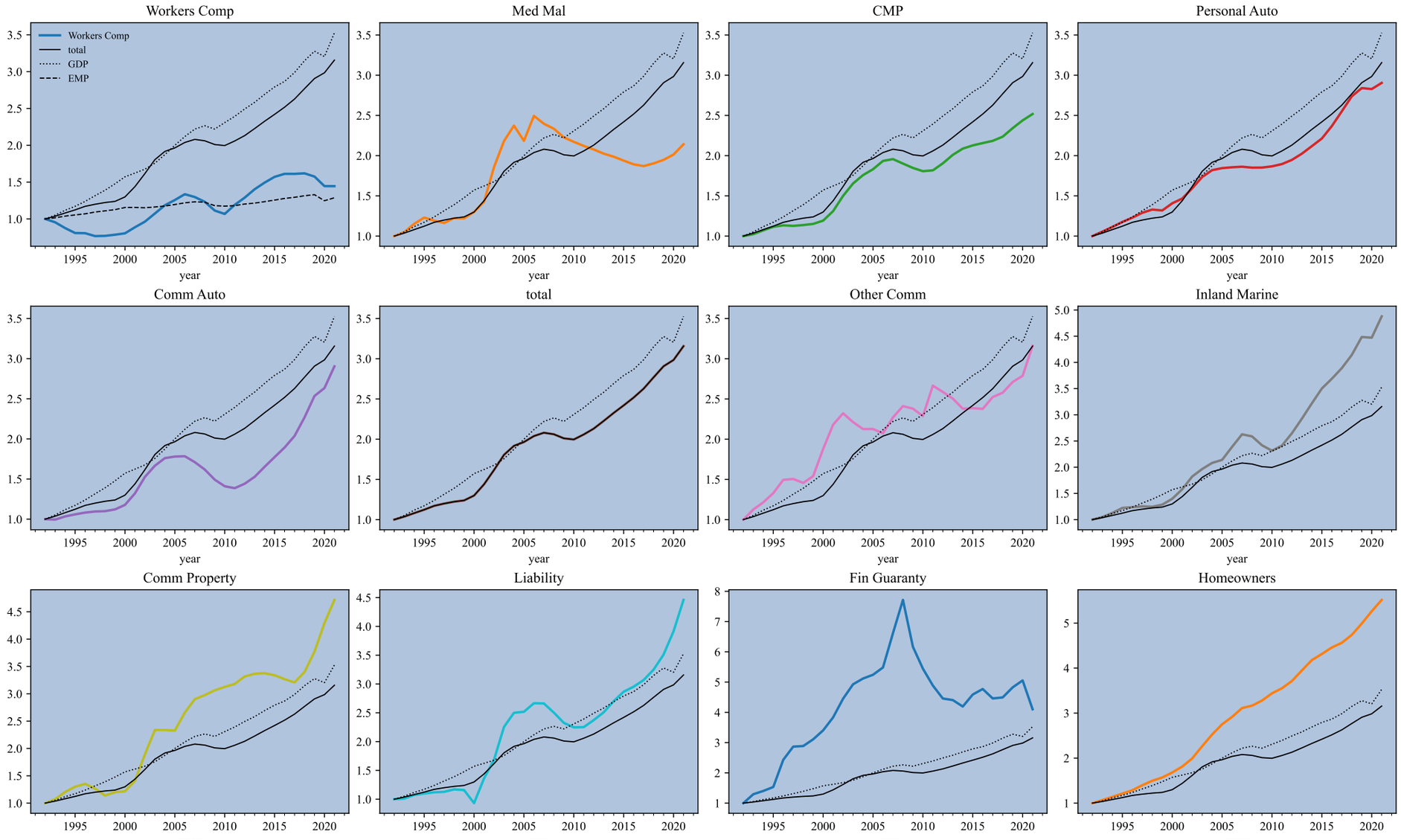

Figure 35: Lines sorted from slowest to fastest average growth rate, since 1992. The workers compensation plot includes the overall level of employment `EMP` from the FRED series CE16OV. WC premium has declined as productivity has improved. Broadly, labor inputs have become less important in higher-risk segments of the economy. Commercial auto is particularly interesting.

C.06. Implications

Implications

Loss ratio and margin expectations

- Adjusted Insurance Operating Ratios averages 13%
  - Net basis
  - Pre-tax
  - Including all investment income
- Considerable variation in underlying loss ratio by line
- By line asymptotic (large portfolio) direcet loss ratio CVs range from 5% for personal auto to 45% for commercial property
- Smaller portfolios will have larger CVs
- Total industry loss ratio CV is 9% direct and 7% net

Margin expectations

- Average historical pre-tax, net margin based on industry data 1992 to 2021
  - -4% underwriting income to net earned premium
  - 9% excluding capital gains and
  - 12% including all capital gains
- Over period, investment income declined from over 20% to less than 10% of net earned premium
- A pricing model producing a gross margin of 8 to 10% is consistent with realized experience 1996-2021

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